AD A 020939

DNA 3741F-2

DNA MASTER FILE OF GROUND-SHOCK, AIR-BLAST, AND STRUCTURE-RESPONSE DATA

Volume 2: Appendixes

Agbabian Associates
250 North Nash
El Segundo, California 90245

1 November 1975

Final Report for Period 1 November 1974 – 15 September 1975

Prepared for
  Director
  DEFENSE NUCLEAR AGENCY
  Washington, D.C. 20305

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER DNA 3741F-2	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) DNA MASTER FILE OF GROUND-SHOCK, AIR-BLAST, AND STRUCTURE-RESPONSE DATA VOLUME 2: APPENDIXES		5. TYPE OF REPORT & PERIOD COVERED Final Report 1 Nov 1974 to 15 Sept 1975
		6. PERFORMING ORG. REPORT NUMBER R-7530-1-3892
7. AUTHOR(s) James A. Malthan		8. CONTRACT OR GRANT NUMBER(s) DNA001-75-C-0154
9. PERFORMING ORGANIZATION NAME AND ADDRESS Agbabian Associates 250 N. Nash Street El Segundo, California 90245		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS NWED Subtask Y99QAXSD164-07
11. CONTROLLING OFFICE NAME AND ADDRESS Director Defense Nuclear Agency Washington, D.C. 20305		12. REPORT DATE 1 Nov 1975
		13. NUMBER OF PAGES 67
14. MONITORING AGENCY NAME & ADDRESS(If different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

This work was sponsored by the Defense Nuclear Agency under NWE D Subtask Code Y99QAXSD164, Work Unit Code 07. This report also includes the early work performed under Contract Number DNA001-73-C-0058, NWE T Subtask Code L17DAXSX318, Work Unit Code 01.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Air Blast	High-Explosive Tests	DIPOLE WEST	MINE ORE	MIXED COMPANY
Data Display	Height-of-Burst Tests	DISTANT PLAIN	MINE THROW	PRE-MINE THROW IV
Data Management	Structure Response	FLAT TOP	MINE UNDER	PRAIRIE FLAT
Data Processing	DATA/70S	MIDDLE GUST	MINERAL LODE	SAILOR HAT
Ground Shock	DIAL PACK	MIDDLE NORTH	MINERAL ROCK	SNOWBALL

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A master file of air-blast, ground-shock, and structure-response data was created from selected high-explosive field tests. The computer software used in forming and maintaining the master file is described and the available processing options are discussed. A compilation of data not included in the master file is also presented.

DD FORM 1473 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE

SUMMARY

For more than a decade, measured air-blast, ground-motion, and structure-response data have been acquired from a variety of high-explosive field tests. *Volume 1: Archive Description and User's Information* summarizes the activities of the past several years to locate and acquire some of the most important groups of these data, preparatory to general accessing by users.

A brief background of the tests that contributed to the formation of the master file of data is presented, together with an extensive bibliography of relevant published documents. Also discussed are the identification system used in cataloging the data, the documentation procedure describing the master file content, the procedures required to retrieve data from the archive, and the various output formats available to the potential user. The descriptive material is accompanied by various illustrations, and an example case is presented to demonstrate the retrieval, processing, and plotting procedures.

Volume 2: Appendixes presents a summary of the data available at Physics International Company; and a detailed description of the computer software used in forming and maintaining the data archive. The various processing options available to reduce, reformat, and analyze data are included.

PREFACE

The formation of the master file of high-explosive data described in this report and the use of the data management and data processing software to retrieve, process, and display the data were authorized and supported by the Defense Nuclear Agency. Major R. Waters was the Contracting Officer's Representative (COR) during the early part of the program. Lt Col. D. Burgess was the COR for the remainder of the work. The initial effort was performed under Contract No. DNA001-73-C-0058, NWE T Subtask Code L17DAXSX318, Work Unit Code 01 and NWE D Subtask Code Y99QAXSD164, Work Unit Code 01. The work was completed under Contract No. DNA001-75-C-0154, NWE D Subtask Code Y99QAXSD164, Work Unit Code 07.

A project of this type requires the support and patience of many individuals in various organizations. It is not possible to acknowledge the many participants who contributed to the ultimate success of the project. Nevertheless, special thanks must go to Messrs. L. Ingram and J. Brogan of the Waterways Experiment Station; Messrs. J. Gordon and H. Jenkins of the Air Force Weapons Laboratory; Mr. J. Keefer of the Ballistics Research Laboratories; Mr. E. Martin and Dr. L. Kennedy of GE TEMPO; Dr. T. Stubbs of Physics International Company; and Mr. J. Carpenter of R & D Associates.

Agbabian Associates personnel who contributed extensively to the project were J. Malthan, Project Manager; E. Raney, Project Engineer; and R. H. Brandt, Staff Engineer. Technical editing of the final report was performed by J. Radler.

ii

CONTENTS

Volume II

ILLUSTRATIONS

TABLES

APPENDIX A

MEASURED DATA AT PHYSICS INTERNATIONAL COMPANY

Table A-1 presents a summary of the data available at Physics International for HE and nuclear tests. These data are reported to be available on digital and analog magnetic tapes or on strip charts. For recommendations concerning the disposition of these data, refer to the source document.[*]

---

[*]*Feasibility of Archiving, at Agbabian Associates, The Ground Motion Data Residing at Physics International Company*, DNA 3631F (San Leandro, CA: Physics International Co., 5/75).

TABLE A-1. SUMMARY OF PI TEST EVENTS DATA

Digital Magnetic Tape

DIAMOND MINE	DISTANT PLAIN 6	MIDI MIST	MING VASE	PRE-MINE THROW IV-2
DIAMOND ORE	DORSAL FIN	MINE ORE	MISTY NORTH	PRE-MINE THROW IV-3
DIAMOND SCULLS	FLAT TOP I	MINE UNDER	PILE DRIVER	PRE-MINE THROW IV-4
DIANA MIST	FLAT TOP II	MINE THROW I	PRAIRIE FLAT	PRE-MINE THROW IV-5
DIESEL TRAIN	FLAT TOP III	MINERAL ROCK	PRE-MINE THROW III	PRE-MINE THROW IV-6
DISTANT PLAIN 1A	HUDSON SEAL	MINERAL LODE	PRE-MINE THROW IV-1	PRE-MINE THROW IV-7

Analog Magnetic Tape

ALVA	DORSAL FIN	FLAT TOP III	MINT LEAF	SMALL BOY
CYPRESS	DURYEA	HUDSON MOON	MISTY NORTH	TINY TOT
DIAMOND DUST	FLAT TOP I	HUDSON SEAL	PILE DRIVER	RED HOT
DOOR MIST	FLAT TOP II	MING VASE	SALMON	

Analog Strip Chart

ANTLER	ELEPHANT 10	MOLE 300	TEA POT ESS	YUBA
BLANCA EVANS	GNOME	MOLE 400	TUMBLER 1	TEAPOT MET
CACTUS	HARD HAT	PRISCILLA	TUMBLER 2	JANGLE-U
CASTLE-KOON	KOA	RAINER	TUMBLER 3	DUGWAY SERIES
CLEARWATER	MADISON	SMALL BOY	TUMBLER 4	
DRAGON	MOLE 100	SMOKEY	UPSHOT KNOTHOLE 9	
ELEPHANT 9	MOLE 200	TAMALPAIS	UPSHOT KNOTHOLE 10	

APPENDIX B

DATA/70S PROGRAM DESCRIPTION

This appendix presents a description of the DATA/70S Data Base Management and Processing System at an intermediate level of detail. It is formatted for the system analyst who has a requirement to understand the design and operation of the system. A thorough dissertation on the system is presented in the DATA/70S *Reference Manual.*[*]

DATA/70S is a digital computer software program that is used to organize, manage, process, analyze, summarize, and display large quantities of transient, periodic, and random time series data. The automated processing system provides a means of performing an extensive set of classical time series analysis studies without constraints on the volume of input data or the number of data manipulations required. The data management capability provides an efficient method for retrieving and processing selected channels of data from the data base, as well as an automatic capability for cataloging and saving processed data files for future use.

Included in this document are the basic data-management and processing concepts that structure the DATA/70S approach, a description of the functions of the major DATA/70S processing modules, and a discussion of the various modes of operating the system to perform the required data

---

[*]*DATA/70S Data Base Management and Processing System: Reference Manual,* R-3270-3515, rev. ed. (El Segundo, CA: Agbabian Associates, 1975).

management and processing tasks. The actual operational use of DATA/70S is also described, including a discussion of the required computer equipment, analyst/operator/program interfaces, and special programming considerations and features of the system.

B.1   SYSTEM DESIGN OVERVIEW

The basic problem that is solved with the aid of the DATA/70S program is to organize and analyze a set of raw data and produce concise summaries and results that will yield definitive conclusions concerning the data characteristics. The elements and characteristics of this processing task are shown in Figure B-1. The basic processing functions provided by DATA/70S are shown in Figure B-2.

The raw input data may consist of a large number of different sets of measurements from a variety of data sources and in a range of formats.   To analyze the data, it is necessary to construct a data base containing the input files of data organized with identification information, to manipulate and manage the data-base, process and analyze individual data channels and combinations of data channels, save processed files in the data base, and interpret and summarize the results of the analysis. The end result of the process is a summary of valid data with a concise history of the processing steps that produced each final element. The results are most conveniently displayed by plots, which may be used for analyses and comparisons of test data.

B.1.1   THE DATA/70S DATA BASE (MASTER FILE)

The DATA/70S data base consists of a multireel magnetic-tape library designated as the Master File. Each tape contains a tape header-label

INPUT
RAW DATA

DATA PROCESSING TASKS

OBJECTIVE

BUILD BASE FILES
ORGANIZE-REFORMAT-EDIT

MANAGE DATA BASE
CHANGE-CORRECT-DELETE-COMPRESS-REPORT

PROCESS DATA FILES
EXTRACT-PERFORM ANALYSIS-PLOT-SAVE PROCESSED FILES

INTERPRET RESULTS
SUMMARIZE-ANALYZE-DETERMINE NEXT PROCESSING STEP

- LARGE SET OF INPUT DATA
- DIFFERENT TEST CHARACTERISTICS
- DIFFERENT DATA SOURCES
- DIFFERENT DATA FORMATS
- NOISE, DRIFT, ERROR PROBLEMS

- DATA BASE EXPANSION
- RANDOM OR SYSTEMATIC DATA FILE EXTRACTION
- TIME AND FREQUENCY ANALYSES PERFORMED
- FLEXIBILITY IN DATA BASE MANIPULATIONS
- DATA CONSOLIDATED INTO INTERPRETABLE FORMS
- SUMMARY OUTPUT PLOTTED

- PROVIDE CONDENSED SUMMARY OF VALID DATA
- COMPARE INTRATEST, INTERTEST, AND CALCULATED DATA
- COMPARE PREDICTIONS WITH TEST RESULTS
- PROVIDE DATA FOR ASSESSMENT
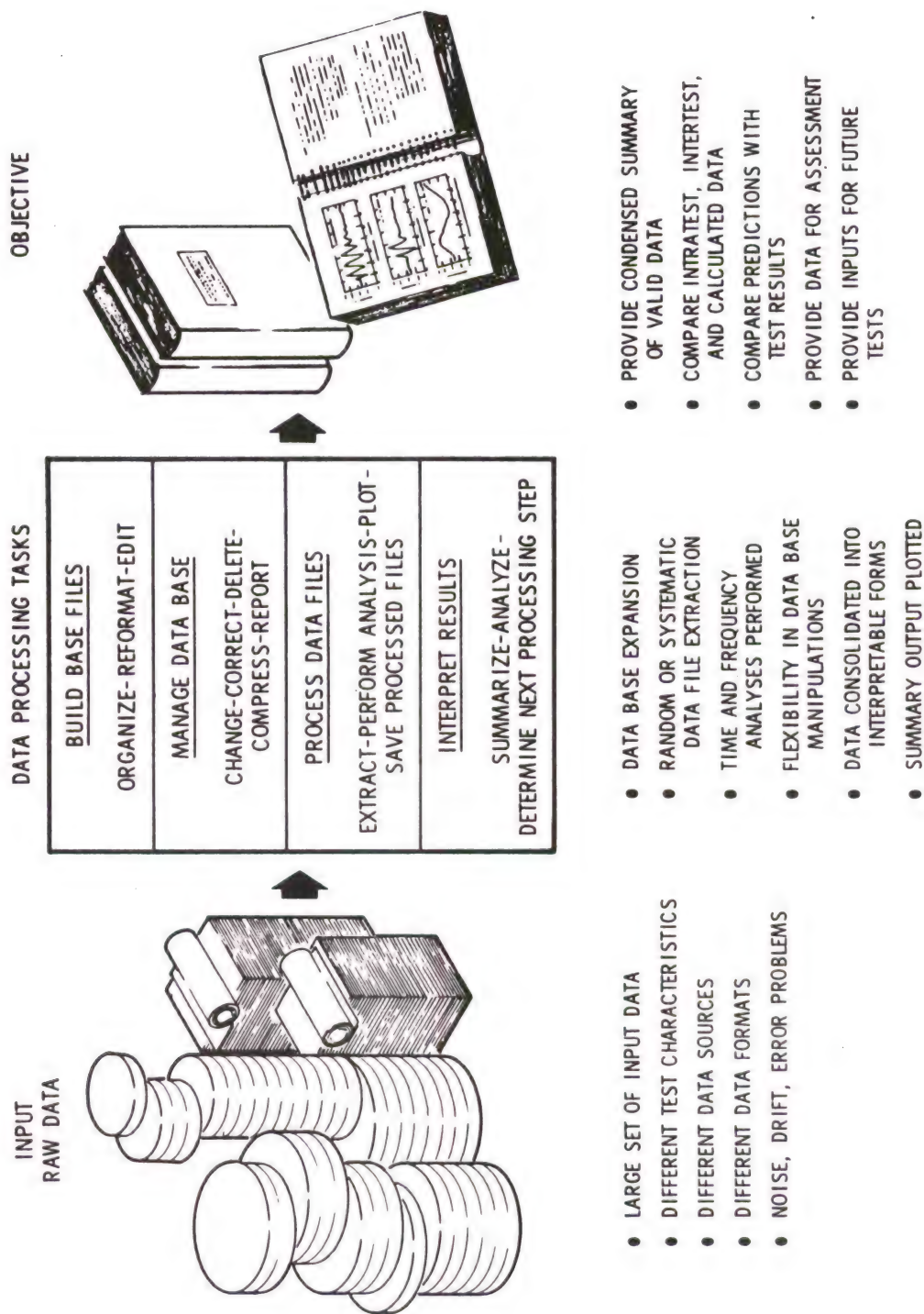- PROVIDE INPUTS FOR FUTURE TESTS

FIGURE B-1. TYPICAL ELEMENTS OF DATA SUMMARIZATION

PREPROCESSING

- A/D conversion or digital data reformatted
- Data calibration
- Keypunch annotation

DATA MANAGEMENT

- Build master file and directory
- Select, edit, and normalize raw data
- Maintain and update master file
  - Corrections, additions, deletions
  - Complete processing history retained
- Extract data
  - Single time-history record
  - Multiple records selected in groups by test event, and measurement type, location, and orientation
- Provide listing and location of every record on file

DATA PROCESSING

- Scaling, time shift, integration
- Filtering and decimation
  Highpass, lowpass, bandpass, bandreject

DATA PROCESSING (CONTINUED)

- Detrending
  Least squares (linear and nonlinear fit)
  Direct subtraction of offset and drift
- Time-domain analysis
  Autocorrelation
  Cross-correlation
- Frequency-domain analysis
  Fourier transform
  Power spectral density
  Transfer functions
- Summarization processes
  Ensemble averaging
  Peak envelope
  Statistical means and deviations

GRAPHICAL AND TABULAR OUTPUT

- Single plots
- Multiple plots
- Overlay plots
- Annotation
- Linear scales
- Semilog scales
- Log/log scales
- Autorange scale selection

FIGURE B-2. DATA/70S BASIC PROCESSING FUNCTIONS

B-4

record and multiple files, each file of which consists of a header record and multiple data records.

The tape-label record contains a user-provided data base identifier and an integer reel-sequence number. (This information is also written on the physical reel to allow for easy identification of the tape.)

Each data channel in the data base occupies one file on a Master File tape. The header record for the file contains the identification words for the data channel (channel ID) that provide the basic data-source designations (e.g., test source, location, codes, depth, etc). The header record for the data channel also includes statistical and summary information about the file, such as sampling rate, sampling start time, mean, variance, number of points, and amount of tape footage required to store the file in the Master File. When Master File data channels are processed with DATA/70S and the resultant file is entered into the data base, the header record is used to record the processing options used in creating the new file and to identify the data channel that was the source for the operation. Thus, the header record for each data channel provides a history of the action taken in producing the file.

The data records for a particular Master File entry follow the header record and contain evenly spaced (based on the sampling rate in the header), time-ordered floating-point numbers. The only restriction on the number of data points is that no file is allowed to span physical reels. Additions to the Master File library are added to the last tape; or if insufficient space is available for the entire file, a new tape is placed in the library with the next sequence number. Therefore, a particular data channel must occupy less than a full physical tape (2400-ft tapes accommodate more than two million points).

B.1.2 THE DATA BASE INDEX (DIRECTORY)

To provide ready access to data channels in the Master File library, the DATA/70S program automatically maintains an index file designated as the Directory.

The Directory is stored on magnetic tape and copied to a direct-access device by DATA/70S for use during program execution. The Directory tape contains a header-label record that provides the corresponding data-base name and a sequential directory tape number (since a new directory is generated each time the Master File is altered). In addition, the label provides the reel number of the last Master File tape, the tape footage currently available on the last tape, and the current number of data channels in the Master File.

The Directory contains a 28-word entry for each data channel in the Master File. Directory entries are ordered by Master File element number, which is a sequential integer assigned when the data channel is added to the library. Hence, the first Directory entry is for Master File element No. 1, which is the first data channel on Master File tape No. 1. Each indexing entry in the Directory contains the channel ID, the location of the channel in the Master File (reel number, file number on the reel, position on the tape in terms of tape footage), a flag indicating whether the file is active or inactive, and the Master File entry number of the parent file if the channel was created by processing an existing Master File data channel.

Hence, the Directory may be used to determine the location in the Master File library of any particular channel ID, to provide a summary of the contents of the Master File library, and to indicate to DATA/70S where to begin adding new channels to the library.

B.1.3 CLASSIFIED DATA BASES (WHERE APPLICABLE)

A special capability is available in the DATA/70S program for handling classified data. The system maintains the Master File in a declassified form by normalizing the data points. To normalize data, all data points in a given data channel are divided by the maximum of the absolute values of all data amplitudes in the channel or by any arbitrary value selected by the user. When such normalized values are written in, the Master File then becomes unclassified, assuming that no classified information is contained in the header records. The classified conversion factor is saved in a separate Classified Directory and is applied as a multiplicative factor to each data point in the channel when the classified values are required during DATA/70S processing. In order to allow completely unclassified executions of DATA/70S, the system maintains two Directory tapes, a classified Directory tape containing the normalizing factors and an unclassified Directory without the factors. Unclassified computer runs may be made whenever normalized data are acceptable; and on the next classified DATA/70S run, DATA/70S will automatically construct a new classified Directory that reflects any changes made to the Master File since the previous classified execution.

A summary of the Master File/Directory features are presented in Table B-1.

B.1.4 THE DATA/70S PROGRAM

As shown in Figure B-1, the major data processing tasks include data-base construction, the data-base management, and data-file processing. The DATA/70S program is constructed to perform these tasks through the execution of a modularly designed, functionally oriented, unified software system.

TABLE B-1.   FEATURES OF THE DIRECTORY AND MASTER FILE

DIRECTORY	MASTER FILE
Disk or Tape File	Multireel Tape Library
• Provides a 28-word format for each data channel in the Master File	• Single tape file for each channel of data
• Locates the data channel in the Master File Library	• Fixed format header record containing alphanumeric, integer, and floating point information for the data channel
• Provides the data normalizing factor	
• Provides the Master File entry number of the parent data channel for new data channels generated by processing	• Multirecord normalized data values in floating-point format
	• No confining restrictions on number or length of data channels in the Master File Library
• Indicates whether the data channel has been deactivated for future automatic processing	• Provides data channel identification, summary statistics, and historical processing information

Basic modules are provided to--

a.   Organize, reformat, and edit raw input data and build corresponding Master File and Directory entries;

b.   Perform basic data-base management tasks, i.e., modify selected Master File header information, deactivate data channels that are no longer needed, print selected Master File or Directory information, and compress the entire Master File library by copying all the tapes to a new tape library and deleting unneeded files; and

c.   Process data files by extracting requested channels from the
Master File library (selected by channel ID or Master File
entry number), performing selected time series analyses on
single or multiple data channels, plotting the basic and/or
processed data, and storing any desired processed files in the
Master File library.

The basic processing modules in DATA/70S are controlled by a single
executive program that interprets user input cards and automatically performs
the options required to accomplish the requested tasks.   The program issues
all required operator instructions (e.g., tape-mount requests) through the
computer console.

B.2.   DATA/70S FUNCTIONAL MODULES

The DATA/70S program is basically organized into five major
processing modules and the utility service modules, as shown in Figure B-3.
The operation of these modules is controlled by the DATA/70S Executive,
based on the user's requests.

B.2.1 INPUT DATA CONVERSION MODULE (EDITOR)

The basic function of the Input Data Conversion Module (EDITOR) is to
convert raw input data into Master File format.   EDITOR accepts binary-coded
decimal (BCD) and binary input tapes in several different formats.   EDITOR
is structured for modification to accommodate raw data tapes in other formats.

EDITOR requires two control-card decks as input.   One set of cards
controls the processing of the series of input tapes, indicating which files of

DATA/70S EXECUTIVE

- PROGRAM CONTROL

UTILITY MODULES

- SYSTEM PARAMETER INPUTS
- GENERAL UTILITY ROUTINES
- INPUT/OUTPUT DEVICE ALLOCATION
- INPUT/OUTPUT SYSTEM INTERFACE
- MASTER FILE TAPE LIBRARY CONTROL
- DIRECTORY OPERATIONS

EDITOR

INPUT DATA CONVERSION MODULE

- EDIT AND COMPUTE STATISTICS FOR INPUT RAW DATA
- GENERATE ANALYTIC DATA CHANNELS
- PRODUCE ENTRIES IN MASTER FILE FORMAT

UPDATE

MASTER FILE PROCESSING MODULE

- PERFORM ALL MASTER FILE LIBRARY MODIFICATION FUNCTIONS
- ADD EDITOR OR POSTPROC PRODUCED DATA CHANNELS TO LIBRARY
- PRINT, MODIFY, OR DEACTIVATE MASTER FILE DATA CHANNELS
- CONTROL DIRECTORY UPDATE TO REFLECT MODIFIED LIBRARY

EXTRACT

DATA PREPARATION MODULE

- RETRIEVE REQUESTED DATA CHANNELS FROM MASTER FILE LIBRARY
- GENERATE MAC/RAN CONTROL INFORMATION
- GENERATE POSTPROC CONTROL INFORMATION
- FORMAT DATA FILE INPUTS FOR MAC/RAN AND POSTPROC

MAC/RAN

DATA PROCESSING MODULE

- PROCESS REQUESTED DATA CHANNELS
- PERFORM REQUESTED ANALYSIS-FILTERING, DETRENDING, CORRELATIONS, SUMMARIZATION, ETC.
- PREPARE PROCESSED DATA FOR POSTPROC

POSTPROC

POSTPROCESSOR MODULE

- PRODUCE REQUESTED PLOTS
- GENERATE HISTORICAL PROCESSING INFORMATION
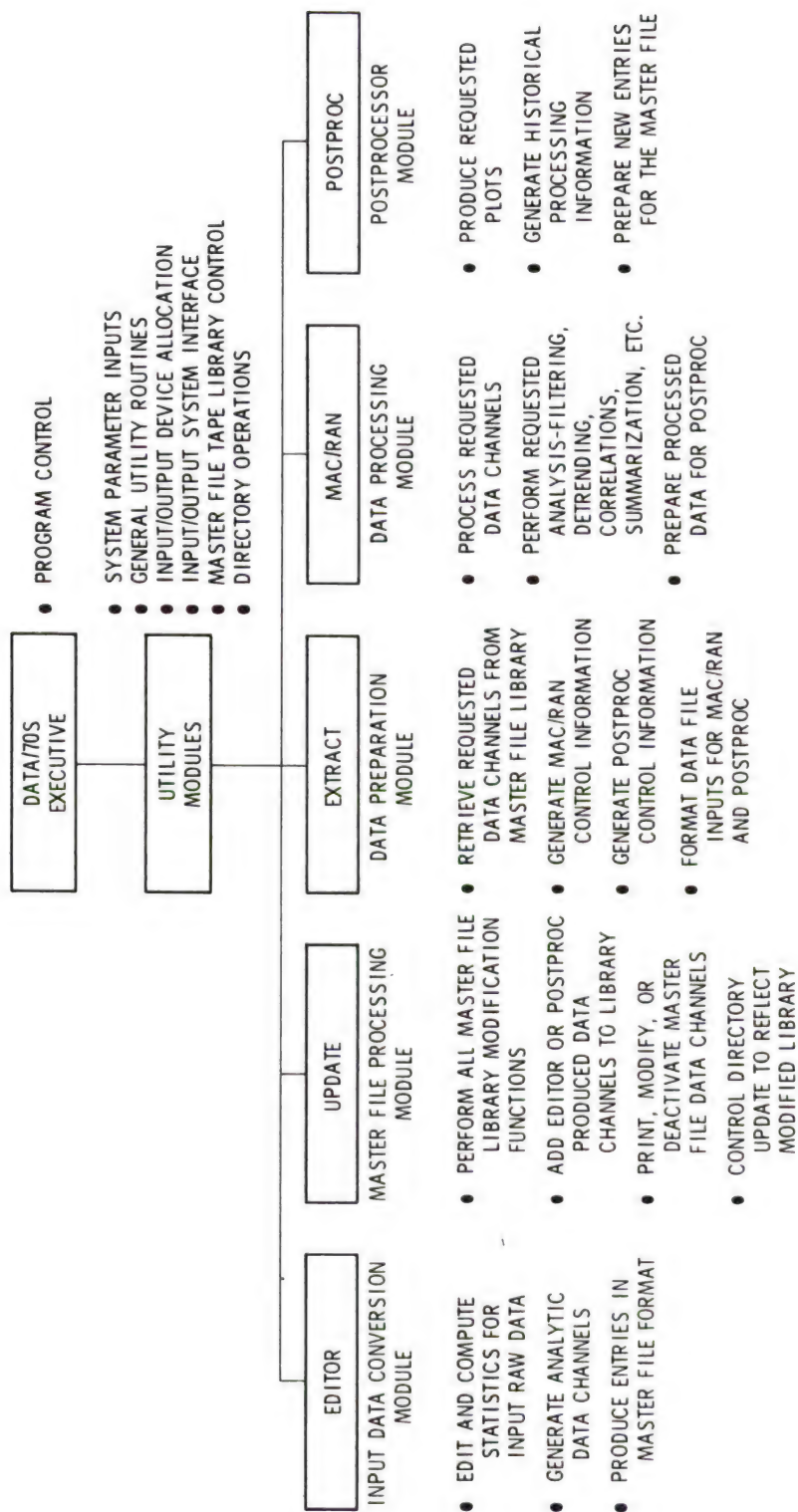- PREPARE NEW ENTRIES FOR THE MASTER FILE

FIGURE B-3. DATA/70S MAJOR MODULE SUMMARY

input data are to be processed or skipped on each tape and the configuration of the input data files on the physical tape reels. Also, the sampling rate may be set through this card deck for each input data channel if it is not available on the tape. The tape file-control logic is independent of the particular input tape format and does not generally require modification when new input tape format capabilities are added to the EDITOR program.

The second set of EDITOR control cards provides annotation data for the output Master File header record for each channel of data to be added to the Master File. Two cards are required for each data channel and provide channel ID information, scaling-factor codes (convert feet to inches by multiplying by 12.0, etc.), and additional descriptive information about the data channel, which is passed to the output header record. An additional field is provided on the header input cards that allows an optional check of a 12-character field punched on the card against a specified field on the input data tape to ensure proper positioning of the input tape. This field is usually activated on selected input files to guard against errors in the input control decks.

The DATA/70S input/output system allows EDITOR to read raw input data tapes and to check each required character for validity during the conversion to floating point format. Out-of-tolerance data points may be rejected and replaced by interpolating new values based on the running mean of the data or by setting the bad values to zero (controlled by user request). This feature allows EDITOR to read damaged or worn field test tapes or to recognize and reject wild-points data.

EDITOR accumulates statistics for each processed data file, including minimum and maximum data values, value of time at the minimum and maximum,

total number of data points, and data mean and standard deviation. These
values are passed to the Master File in the output header record.

The output of EDITOR consists of a Master File header record and
multiple data records for each processed data channel (based on one input
tape file). For each input tape file processed, EDITOR prints any header
information provided on the input tape for the data channel. The input header
cards used in each case to build the output Master File header are printed
along with the above information.

In the DATA/70S program, EDITOR interfaces only with the UPDATE
module, which adds the EDITOR-generated Master File entries to the data base.

B.2.2 MASTER FILE PROCESSING MODULE (UPDATE)

The Master File Processing Module (UPDATE) performs all modifi-
cations to the Master File Library. The module has five basic modes of
operation:

a. EDITOR/UPDATE mode: UPDATE normalizes the data channels
    produced by the EDITOR module and adds the resultant to the
    library.

b. POSTPROC/UPDATE mode: UPDATE merges the header tape
    and data tape information from POSTPROC and adds the resultant
    processed data channels to the Master File library.

c. Pure UPDATE mode: Based on user requests, UPDATE prints
    selected Master File entries; performs modifications to the
    headers of requested entries, deactivates the entry through the

Directory, and adds the resultant to the Master File; modifies the header, time-shifts the data for requested entries, and adds the result to the Master File; or deactivates entries from the Master File through the Directory.

d. Clean-up mode: UPDATE reads the entire Master File library and generates a new compressed tape library. The disposition of each file in this process is controlled by the corresponding Directory entry or by input data cards.

e. Log/Print mode: UPDATE reads and prints the entire Master File library. The information printed for each file is controlled by the corresponding Directory entry or input data cards.

Any changes to the Master File library require corresponding modifications to the system Directory. This is accomplished by UPDATE through the Add/Delete tape, which provides the interface with the Directory Operation Module. The Add/Delete tape contains a complete Directory format entry for each data channel that is deactivated or added to the library. The Directory Operations Module uses this interface tape to add the new entries to the Directory and to set the delete flag for those entries specified as deactivated. A deactivated data channel still exists in the Master File library, but the channel ID will not be selected for automatic processing through the Data Preparation Module (EXTRACT). In addition to the Add/Delete tape, UPDATE will, on option, punch an Add/Delete card deck that may be saved and used as a backup means of regenerating the Directory.

UPDATE operational modes (a) and (b) above are straightforward and consist of merely adding the new data channels to the library and creating the

corresponding Directory entries. UPDATE adds new files to the last reel in the Master File library if there is sufficient space on the tape. Otherwise, a new tape is added to the library and assigned the next sequential reel number.

UPDATE modes (d) and (e) are specialized features for automatically compressing or printing an entire Master File library. In the Clean-up mode, the deactivated files are typically removed from the library. The option is provided to override the automatic selection process by requesting any particular file to be saved or deleted. Also, the header record for a particular data channel may be saved with the data records deleted. This is useful if the data are no longer needed, but the header information serves as a historical processing summary. In the Log/Print mode, UPDATE prints the header record and data values (at an input print sampling rate) for active files and only the header information for deactivated files. As before, this automatic print selection process may be overridden for specific files through card inputs.

The data base management tasks performed by UPDATE in mode (c) are controlled by a user request deck that specifies the data channels to be processed (by channel ID or Master File entry number) and the operations to be performed on the channels. If the header modification option is requested, the original file is deactivated, the modifications specified on the input cards are performed, and the new file is added to the library.

The data-shift option allows zeros to be added or data to be truncated at the beginning or end of a data channel. In addition, the start time of the data channel may be adjusted and modifications made to the header record. In this case, the original channel is not deactivated, but the new channel is added to the library.

In addition to the Add/Delete tape interface with the Directory Operations Module, UPDATE also uses this module to locate and schedule Master File tape requests for the desired Master File data channels.

UPDATE formats and prints the Master File header record information for each data channel added to the Master File. In addition, the data values may be printed at a specified sampling rate. This information may be classified or declassified (normalized) on request.

B.2.3 DATA PREPARATION MODULE (EXTRACT)

The Data Preparation Module (EXTRACT) extracts requested data channels from the Master File library and prepares the input required for the data analysis modules (MAC/RAN and POSTPROC) to perform the requested processing. The process request deck consists of a set of process definition cards followed by the channel IDs of the data channels on which the requested analysis is to be performed. As many groups of process request cards and associated channel IDs as desired may be input to a given EXTRACT execution.

A card-image file is generated by EXTRACT on an intermediate direct-access device to define the operations to be performed on the data channels by the MAC/RAN Module. These MAC/RAN control cards may be punched by DATA/70S on request.

EXTRACT uses the Directory Utility Module to locate and schedule Master File tape requests for the desired Master File data channels. Data files may be requested by specific channel ID, or a set of channel IDs may be requested with specified ID fields ignored (i.e., groups of data channels may be requested using the asterisk notation for each of the channels desired). The

data files to be processed are read from the Master File tapes in the sequence requested and reformatted for use in MAC/RAN or POSTPROC. The interface tape format includes MAC/RAN control words and data point pairs (time and associated amplitude value). On classified runs, EXTRACT converts the amplitude values by multiplying each point by the classified conversion factor supplied by the Directory Operations Module.

In addition to the MAC/RAN control card file, EXTRACT produces three types of output tapes: the MAC/RAN interface tape containing data channels to be processed by MAC/RAN; the POSTPROC interface tape containing data channels bypassing MAC/RAN, to be processed directly by POSTPROC; and the POSTPROC header tape, which includes the original input-request card images and the Master File header record associated with each processed data channel.

EXTRACT printout provides a summary of the requested processing options and channel IDs and a history of the generated MAC/RAN control-card images.

B.2.4 DATA PROCESSING MODULE (MAC/RAN)

The Data Processing Module (MAC/RAN) performs the basic time series analysis functions for the DATA/70S program. The input to MAC/RAN is provided by the EXTRACT Module, and includes control-card images describing the requested analysis options and the original data channel to be processed.

MAC/RAN writes the processed data files on tape for the POSTPROC module, which plots the resultant files and/or formats the files for storing in

the data base. MAC/RAN also writes a file on direct access, which contains statistical information about each data channel. This information is used by POSTPROC as well as internally in MAC/RAN, and may be punched on request to ensure restart capability.

MAC/RAN, a self-contained module within DATA/70S, contains its own executive for data-flow control and PRINT and PLOT processors for printing and plotting options independent of the capabilities in the DATA/70S POSTPROC Module. The EXEC Module operates independently of the DATA/70S user; the PRINT and PLOT Module is available to the user on command. The data processing modules in MAC/RAN include the following:

Executive	Printer and Plotter Output
Calibration	Time and Frequency Analysis
Data Preparation	Linear Systems Analysis
Amplitude Statistics	Ensemble Averaging Technique
Fourier Transform	Shock Spectrum
Power Spectral Density	One-Third Octave
Out-of-Core Power Spectral Density	Phase Lock Loop Tracking Filter
Plugboard Simulation	Preloading
Convolution and Filtering	Time and Frequency
Card to Tape	Convolution and Detection

A description of each MAC/RAN Module is described in the following sections. A more detailed description is presented in the MAC/RAN *Reference Manual.*[*]

---

[*]*Reference Manual*, *MAC/RAN III*, R. K. Otnes, ed. (El Segundo, CA: Agbabian Associates, 1973).

B.2.4.1 Executive Processor (EXEC)

The control portion of the MAC/RAN system is the Executive Processor. The EXEC controls the overall operation of the system through control cards that are supplied as input for any given job.

B.2.4.2 Calibration Processor (CALIB)

The Calibration Processor provides the capability to convert raw digitized data from "counts" to meaningful engineering units. It also permits adjustments to be made for offsets and nonlinearities introduced into the data by the collecting and recording devices.

B.2.4.3 Data Preparation Processor (PREP)

The Data Preparation Processor performs four functions usually encountered after any required calibration: wild-point editing, trend removal, numerical filtering, and decimation.

B.2.4.4 Amplitude Statistics Processor (AMSTAT)

The Amplitude Statistics Processor computes the sample probability distribution function and performs a chi-square goodness-of-fit test for normality (Gaussianess). In addition, it can compute the sample mean, sample variance, sample standard deviation, and third and fourth sample moments for each time history.

B.2.4.5 Fourier Transform Processor (FOUR)

The Fourier Transform Processor computes the Fourier transform of real time-history data or the inverse Fourier transform of complex

frequency data. Up to 12 time histories or 12 complex frequency functions may be processed at one time. If possible, computing is done in core; if not, the transform is computed using auxiliary storage.

B.2.4.6 Power Spectral Density Processor (PSD)

This processor employs several implementations of the fast Fourier transform (FFT) to compute power spectral densities, cross-spectral densities, simple transfer functions, and coherence functions. Several spectral windows are available. Analysis procedures to attain specified resolution bandwidths may be selected from several schemes.

B.2.4.7 Out-of-Core Power Spectral Density Processor (BIGPSD)

The out-of-core power spectral density is employed in conjunction with the FOUR Processor to compute power spectral densities in certain special cases where the PSD Processor would not be appropriate. PSD can process out-of-core data, but it divides the data into segments. This induces a window larger than that occurring when the whole series is used, thus resulting in more leakage.

B.2.4.8 Plugboard Simulation Processor (PLUG)

The purpose of the Plugboard Simulation Processor is to simulate a large variety of analog-type calculations with their discrete equivalent, and to allow the user to perform a large variety of operations upon the data. PLUG manipulations fall into seven categories: arithmetic operations, such as addition, subtraction, etc.; elementary real functions, such as log, exponential, sin, cos, arctan, etc.; complex arithmetic and functions; digital filtering; data

generation including time, frequency, and random data in either uniform or Gaussian distribution; and testing and transfer operations.

B.2.4.9 Convolution and Filtering Processor (CONFIL)

This processor uses implementations of the fast Fourier transform algorithm to perform convolution correlation and filtering. Several computation options are available in CONFIL. When filtering is required, either the unit impulse response h(t) or the transfer function H(f) may be utilized. It is also possible to obtain the product of a transfer function with the power spectral density $G_x(f)$ of a time series. This product corresponds to the PSD of the filtered time series. Convolution, correlation, and filtering options may be performed on time series of unlimited length.

B.2.4.10 Card to Tape Processor (CTAPE)

The Card to Tape Processor operates in three modes. In the first mode, it reads data punched in the MAC/RAN standard control card format (SCC) from the standard input tape and writes the data on tape in the MAC/RAN standard intermediate data tape (SIDU) format; in the second, it reads a format statement, and then reads punched cards in that format and outputs the data in the SIDU format; in the third mode, the process is reversed: the processor reads in a MAC/RAN SIDU and punches those data out on cards in the standard card format. Channel directory cards are generated in both modes one and two.

B.2.4.11 Printer and Plotter Output Processor (PLOT)

The Printer and Plotter Output Processor provides a convenient means for listing and/or plotting output from any data tape in MAC/RAN. Any

function or combination of functions from a file computed with the MAC/RAN system and written on tape may be saved and later printed or plotted by the Printer and Plotter Output Processor.

B.2.4.12   Time and Frequency Analysis Processor (SPEC)

The basic outputs of the Time and Frequency Analysis Processor are auto- and cross-correlation functions, and power and cross-spectral density functions computed from a pair of time histories. The processor can simultaneously analyze two sequences of unlimited sample lengths. The classical Blackman-Tukey computation procedure is implemented in this processor. That is, the correlation function is first computed, followed by a Fourier transformation to obtain the spectral density function.

B.2.4.13   Linear Systems Analysis Processor (TRANS)

The Linear Systems Analysis Processor operates on spectral density matrices from order 2 up to a maximum of 25. Frequency response functions, coherence functions (ordinary, multiple, and partial) and associated confidence limits are computed for single-input/single-output and for multiple-input/single-output linear systems.

B.2.4.14   Ensemble Averaging Technique Processor (ENSAV)

The Ensemble Averaging Processor accepts a set of up to 24 time histories and produces as output a file of ensemble information. The file contains the mean, mean square, sum, sum of squares, and the variance. Each of the time histories may be time-advanced, scale-aligned, and weighted, prior to the averaging process. These transformations provide the alignment and zero adjustment that may be required.

B.2.4.15 Shock Spectrum Processor (SHOCKS)

SHOCKS calculates the peak responses of a set of second-order mechanical systems (each such system tuned to a different natural frequency) to the shock produced as a function of their natural frequencies.   The response history is broken into primary and residual time periods from which five peak responses are calculated: primary positive, primary negative, residual positive, residual negative, and the maximax.

B.2.4.16 One-Third Octave Processor (THROCT)

One-Third Octave Analysis employs proportional, rather than constant, bandwidth frequency analysis. This is accomplished by using a series of band-pass filters covering the various frequency ranges. A variety of computational options are available within this processor. These options include RMS time history, one-third octave filtered time history and power, and RMS spectrum and spectral density functions.

B.2.4.17 Phase Lock Loop Tracking Filter (PHLOOP)

The Phase Lock Loop Tracking Filter Processor tracks a function, basically sinusoidal, that is varying with time. Based on the tracked frequency, PHLOOP may optionally track a second function and compute coherence between the two functions. Harmonics of the second function may also be tracked.

B.2.4.18 Preloading Processor (PRELOD)

This processor is used to preload a scratch storage unit with a set of data. It is to be used in conjunction with the PREP and CONFIL Processors.

B.2.4.19 Time and Frequency Processor (TRIDEE)

The Time and Frequency Processor computes the minimum bandwidth Power Spectral Density of adjacent segments of a time history, and plots these frequency segments in an overlapping manner, so that the result is effectively a three-dimensional plot with power as the dependent variable, and time and frequency as the independent variables.

B.2.4.20 Convolution and Detection Processor (CONDET)

The Convolution and Detection Processor detects repetitive events and computes their average and variance after they are detected. The detection is done through a convolutional procedure (matched filter) whereby the entire data sequence is convolved with a mask function. If the result of the convolving process falls within the specified limits, a detection is assumed to have occurred.

B.2.5 POSTPROCESSOR MODULE (POSTPROC)

The Postprocessor Module (POSTPROC) accepts output from the Data Preparation Module (EXTRACT) and the Data Processing Module (MAC/RAN), and provides a means for output file (i.e., data channel) disposition. The main functions of POSTPROC include:

- Identification of the output data channel

- Updating of the header to retain the processing history and the process parameters

- Updating of the basic statistical parameters

- Provision of user-requested plotted, printed, and punched output

- Reformatting of user-selected data channels to be returned and saved in the Master File

POSTPROC accepts a header tape provided by EXTRACT, which contains groups of process definition cards, channel ID cards, and the Master File headers of each ID to be processed. The header tape is interrogated by POSTPROC to identify the processes performed on each data channel and to determine the disposition of the output data channels. The processed data channels are provided to POSTPROC on MAC/RAN output-data tapes and an EXTRACT bypass tape. For each ID with a process group string, POSTPROC scans the process definition cards to determine the number and location of the output data channels. The original Master File header is updated with statistical information obtained from the MAC/RAN out-put. In addition, POSTPROC updates the ID and header to denote processed data (i.e., integrated velocity channels become displacement channels, etc.) the processes performed, the process parameters used, and the input (or source) data channel. Based on disposition cards, each output data channel and its updated header is plotted, printed, punched, returned to the Master File, or destroyed.

The basic plot format allows the user to display from one to four graphs per page, with multiple data curves per graph. Linear, semilog, and log/log graphs are available and can be intermixed on the same page. Upon user request, graphs can share common x-axes and common y-axes, and curves can be plotted over a portion of their entire range. In addition, each curve is provided with annotation that shows the updated ID, key source and statistical data, process history, and the process parameters. Output data

channels that are to be returned to the Master File are written to tape for the UPDATE module.

B.2.6 UTILITY MODULES

The utility DATA/70S modules provide those capabilities required for the overall operation of the system. These include general service and input/output functions, presetting system-control parameters and processing input-system control cards, assigning logical units for each module, and controlling the input of the Master File tapes.

B.2.6.1 General Service Routines

Several subroutines in the DATA/70S program perform general processing and utility tasks, and are used by more than one module. Examples of such routines are a timing routine, the general display package that controls all console messages, and tape label processing routines.

B.2.6.2 System Input Processor Module

The System Input Processor Module is executed at the beginning of each DATA/70S run to set up the run itinerary and to set all system-control parameters, which are maintained in a common core area and are available to all processing modules. The Input Processor presets the control parameters and then reads input data cards to override the nominal values. Examples of system-control parameters are record lengths for various data files, number of characters per computer word for the computer system in use, maximum

number of feet available on Master File tapes, sequence number of the latest Directory tape, and various print and punch option requests. More than 125 control parameters are used in the DATA/70S program.

B.2.6.3 Input/Output Module

The Input/Output Module contains all the routines used for non-FORTRAN I/0 within the DATA/70S program. Capabilities are provided for block read and write, automatic double-buffering of reads and writes, rewind, record skip forward or backward, file skip forward or backward, write file mark, and tape unload. On computer systems with drum devices rather than disks, a drum-positioning feature is also provided. The major subroutine that interfaces with the computer operating system I/0 routines is machine dependent and is generally written in assembly language.

B.2.6.4 Input/Output Device-Allocation Module

The DATA/70S Program is a combination of modular subsystems that communicate with each other and with the data base, primarily through tape and direct-access files. The Input/Output Device Allocation Module coordinates and optimizes logical unit assignments throughout DATA/70S. The data transmittal problems that are handled through the Device Allocation Module include adaptation of mixed-width tape systems, allocation of logical units to direct-access devices, and assignment of available tape drives.

In a fixed channel system, simultaneous I/0 operations must be distributed as evenly as possible among the data transmission channels. Overall operating time is greatly decreased in runs requiring a large amount of tape

handling by optimizing the order and location of tape mounts. Scratch tapes remaining from a previous function may be left mounted as output tapes, and new tape mounts should be made on open drives or drives most likely to have the previous tape dismounted. Tapes that are to be used by some later module should remain mounted, if possible. In the case of mixed-width tape systems, any remount must be on a similar device. Multireel files must also be considered, since several or all of the reels still mounted at the end of module execution may be retained in the next module configuration. Also, some files in DATA/70S may be assigned to direct-access units or tape units, depending on the availability of tape drives and the type of computer in use.

In general, all assignment and logical unit information is determined for a module just prior to its execution. These requirements are satisfied by the Device Allocation Module according to the individual needs of the module and in conjunction with the other modules used in the run.

B.2.6.5 Master File Tape Handling Module

The Master File Tape Handling Module controls the input of Master File tapes for the UPDATE and EXTRACT Modules. The Tape Handling Module requires an array containing the tape and file numbers and tape footage for each file requested. This array is generated by the user modules based on information provided by the Directory Operations Module, which interfaces directly with UPDATE and EXTRACT.

The Tape Handling Module may use up to five tape drives for input. Mount messages are displayed that give the required Master File tape numbers. The tapes may be mounted on any available input drive. The user subsystem

calls the Tape Handling Module when it is ready to process the next requested input data channel. The Tape Handling Module returns the logical unit containing the file after the tape has been properly positioned. On each call the Tape Handling Module checks the status of all the input tape drives. Wait time is minimized by issuing tape positioning commands (file skips, rewinds, unloads) based on calculation of the time required to complete the previous operation on the unit. The use of this timing technique ensures that no wait will occur unless all of the input tape drives are operating or all of the required positioning commands for processing have been issued.

B.2.6.6 Directory Operation Module

The Directory Operations Module performs all functions associated with printing, updating, and locating Master File entries from the system's Directory tapes. The Directory Operations Module operates in three basic modes:

    a.   Directory Initialization Mode

    b.   Directory Update Mode

    c.   Directory Scheduling Mode

The Directory Initialization function is performed immediately prior to the execution of the first subsystem that requires the Directory.

The basic functions of the Directory Initialization mode of operation are to--

    a.   Request Directory tape mounts and verify the validity of the input Directory.

b.   Copy the latest Directory to direct access for later subsystems.

c.   Generate a Directory tape from input cards on request
     (backup mode of operation).

d.   On classified runs, update the classified Directory to the level
     of the input unclassified Directory.

The Directory Update function is automatically performed by the
DATA/70S Executive at the conclusion of any run that requires the Directory.
In addition, the Directory Update function may be executed in the stand-alone
mode to perform utility Directory functions.

The basic functions of the Directory Update subsystem are to--

a.   Generate an Add/Delete tape from input cards, if requested
     (backup mode of operation).

b.   Process the Add/Delete tape generated by the UPDATE
     subsystem or from input cards and perform the requested
     modifications to the system Directories.

c.   Build the final output Directories.

d.   Print the latest Directory in sequential order as entered on the
     Master File or in ID-sorted order, and punch the Directory
     on cards by request.

On an unclassified run, a new unclassified Directory tape will be
generated if an Add/Delete tape or Add/Delete cards are input. The delete

flag will be set for those entries specified for deactivation and the new entries will be added to the end of the Directory. The newly deleted entries and the added entries are flagged on the output unclassified Directory as updated entries. This allows the Directory Initialization function to build a corresponding classified Directory tape on the next classified run of DATA/70S.

On a classified run, new classified and unclassified Directory tapes will be generated if an Add/Delete tape or Add/Delete cards are input, or if the Directory Initialization function generated a new classified Directory in the run.

The Directory Scheduling function is called by the UPDATE and EXTRACT Modules to determine the positions in the Master File library of the entries requested for processing. The entire Directory entry for each scheduled channel ID is returned to the calling program. The information of particular interest is the Master File tape number, file number on the tape, and tape footage to the file. The calling module extracts this information from the interface array and builds an array to be used by the Master File Tape Handling Module in mounting and positioning the required tapes.

The Directory Scheduling Module has two modes of operation: standard and span scheduling. In the standard mode, used by both UPDATE and EXTRACT, the calling program provides a channel ID or Master File entry number in the interface array for each Master File entry to be processed. In the span scheduling mode used by EXTRACT, a basic channel ID is provided with one or more of the ID subfields indicated as arbitrary. The Directory Scheduling Module schedules any channel ID in the Directory for which the fixed subfields match.

B.3 DATA/70S OPERATIONAL MODES

The flow of data through the major DATA/70S processing modules is shown in Figure B-4. This flow of data is accomplished through three principal modes of operation of DATA/70S:

a. Raw Input Data Mode

b. Processing Mode

c. Master File Management Mode

DATA/70S operates in several additional modes to perform auxiliary data management functions such as Directory utility work, Master File clean-up, or Master File log/print. In addition, any of the Data/70S modules can be executed individually. The majority of DATA/70S executions, however, are in one of the three principal operation modes.

The Raw Input Data Mode is illustrated in Figure B-5. In this mode, the EDITOR Module is called to process raw input data, and the UPDATE Module is used to add the resultant entries to the Master File and to control the Directory update function.

The Processing mode is illustrated in Figure B-6. In this mode, EXTRACT is called to build the interface files for the requested data channels to be processed. If any of the channels are to undergo any of the DATA/70S time series analysis processes, MAC/RAN is called. If plotting or saving of processed or basic data is requested, POSTPROC is called; and if new files are to be stored in the data base, UPDATE is executed.

The Master File Management mode is illustrated in Figure B-7. The only major module required in this mode of operation is the UPDATE Module,
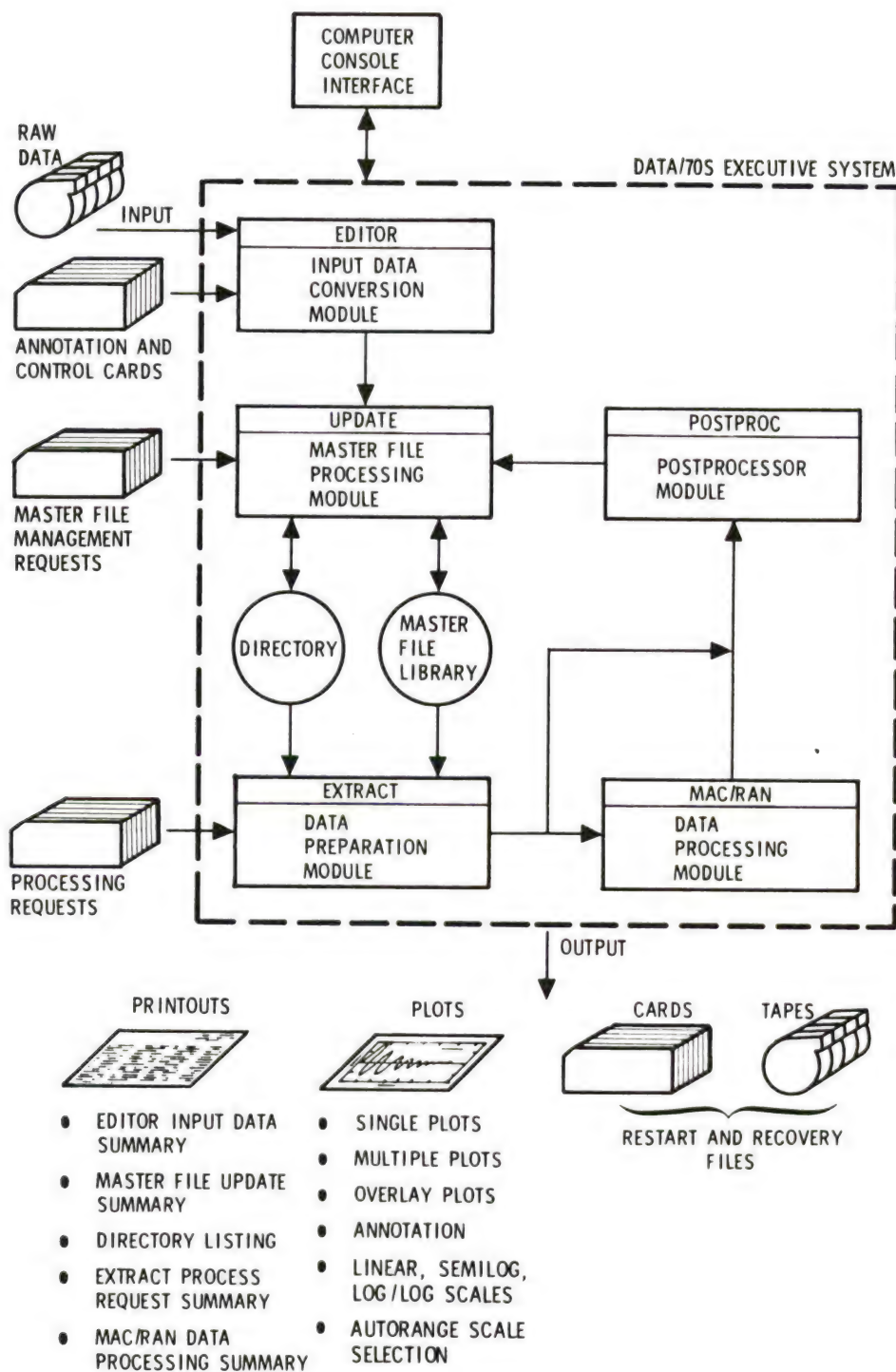
FIGURE B-4.   DATA/70S PROCESSING FLOW
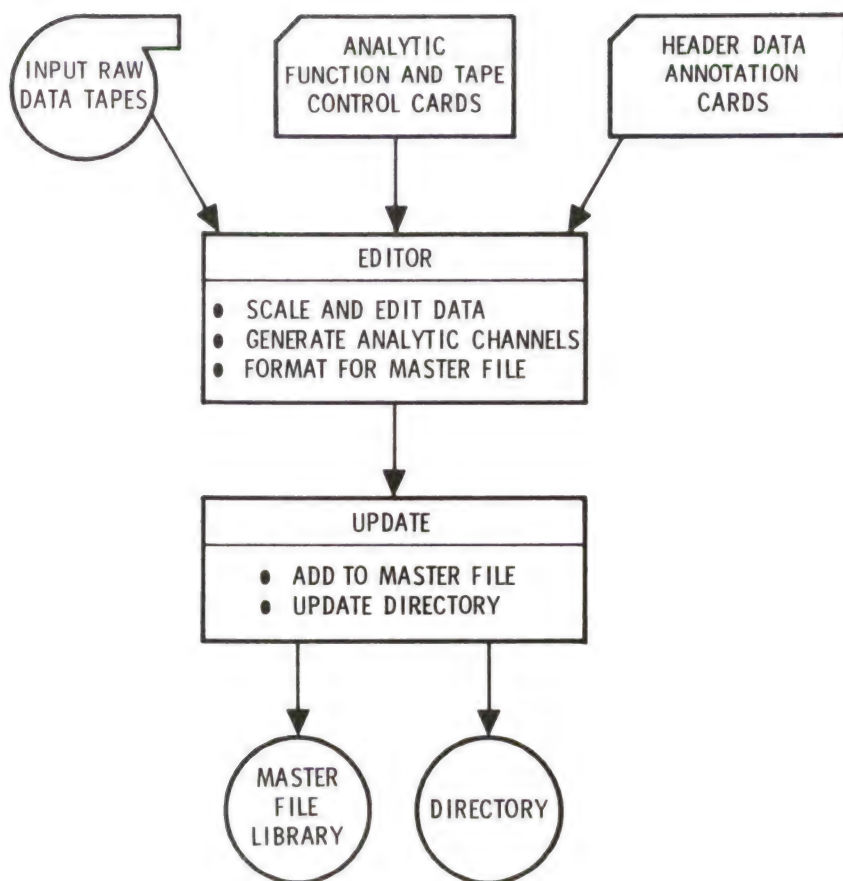
FIGURE B-5.   INPUT MODE, ADDING NEW DATA THROUGH
                DATA/70S
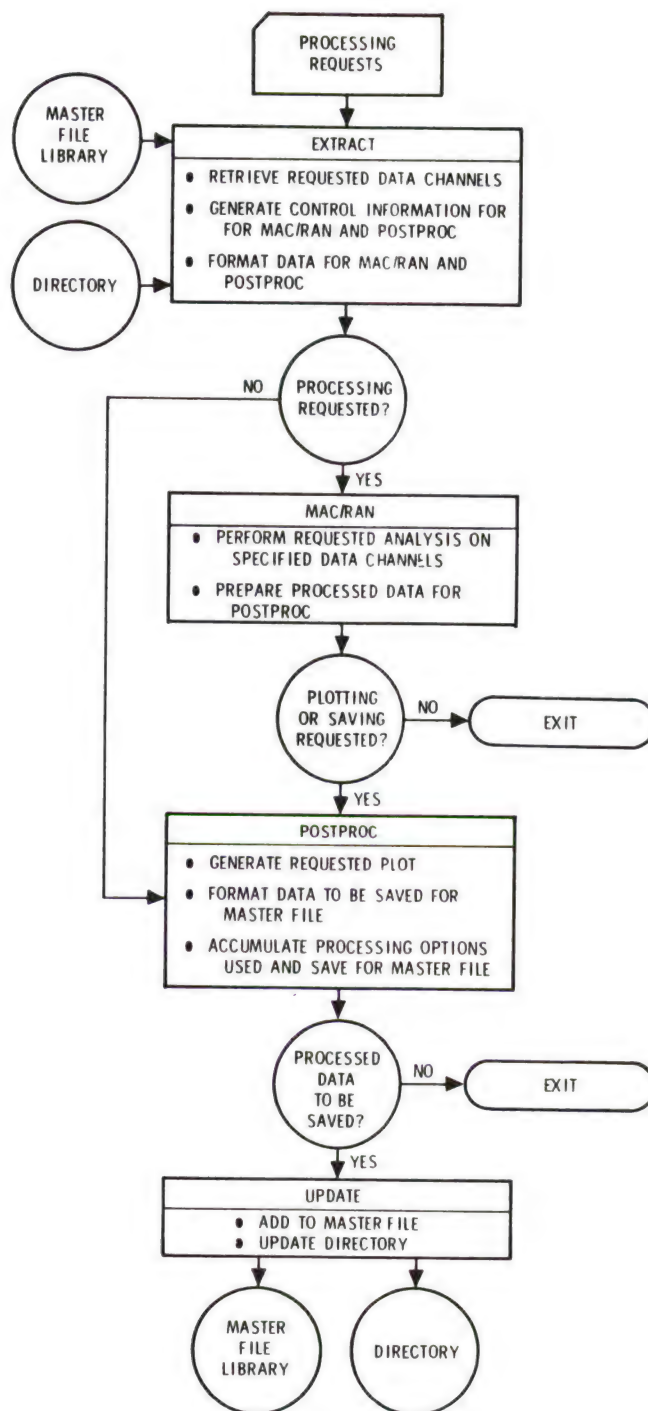
FIGURE B-6. PROCESSING MODE, PROCESSING DATA THROUGH DATA/70S
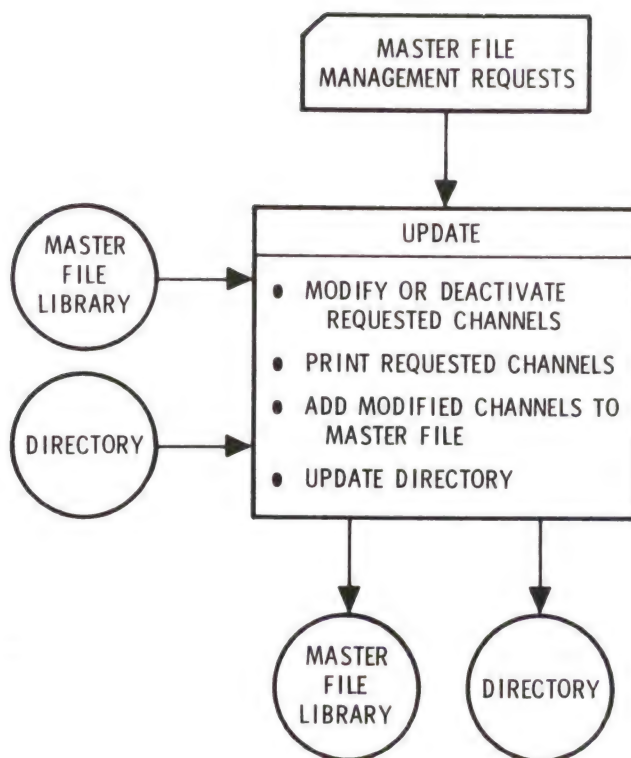
FIGURE B-7. MASTER FILE MANAGEMENT MODE, MANAGING
THE MASTER FILE THROUGH DATA/70S

which performs the desired Master File data-channel printouts, modifications, or deactivations; adds modified data channels to the Master File; and controls the updating of the Directory tape.

B.4   THE COMPUTERIZED SYSTEM

The DATA/70S program is primarily written in the FORTRAN language and consists of more than 35,000 source cards. The program was designed and implemented to be computer independent except for some selected subroutines where consideration for efficiency requires special machine-dependent coding. The program is currently operational on the UNIVAC 1108 and CDC 6600 computer systems and requires $52,000_{10}$ words of core storage on the 1108. DATA/70S is organized into nine overlays, which are called as required by the DATA/70S Executive. These nine overlays correspond to the five major modules (EDITOR, UPDATE, EXTRACT, MAC/RAN and POSTPROC), the two major Directory Operations Module functions (Directory Initialization and Directory Update), the System Input Processor Module and the Input/Output Device Allocation Module. The general utility service subroutines and the Input/Output Module are always core resident along with the DATA/70S Executive routine. The Directory Scheduling function and Master File Tape Handling Module are in core with UPDATE or EXTRACT. An overview of the DATA/70S overlay structure is shown in Figure B-8 with a given branch of the "tree" representing a set of programs that may be in core together.

The control cards required to execute DATA/70S (not including the individual-module data decks) specify the operational mode to be run, the sequence number of the current Directory tape, and data cards for any changes
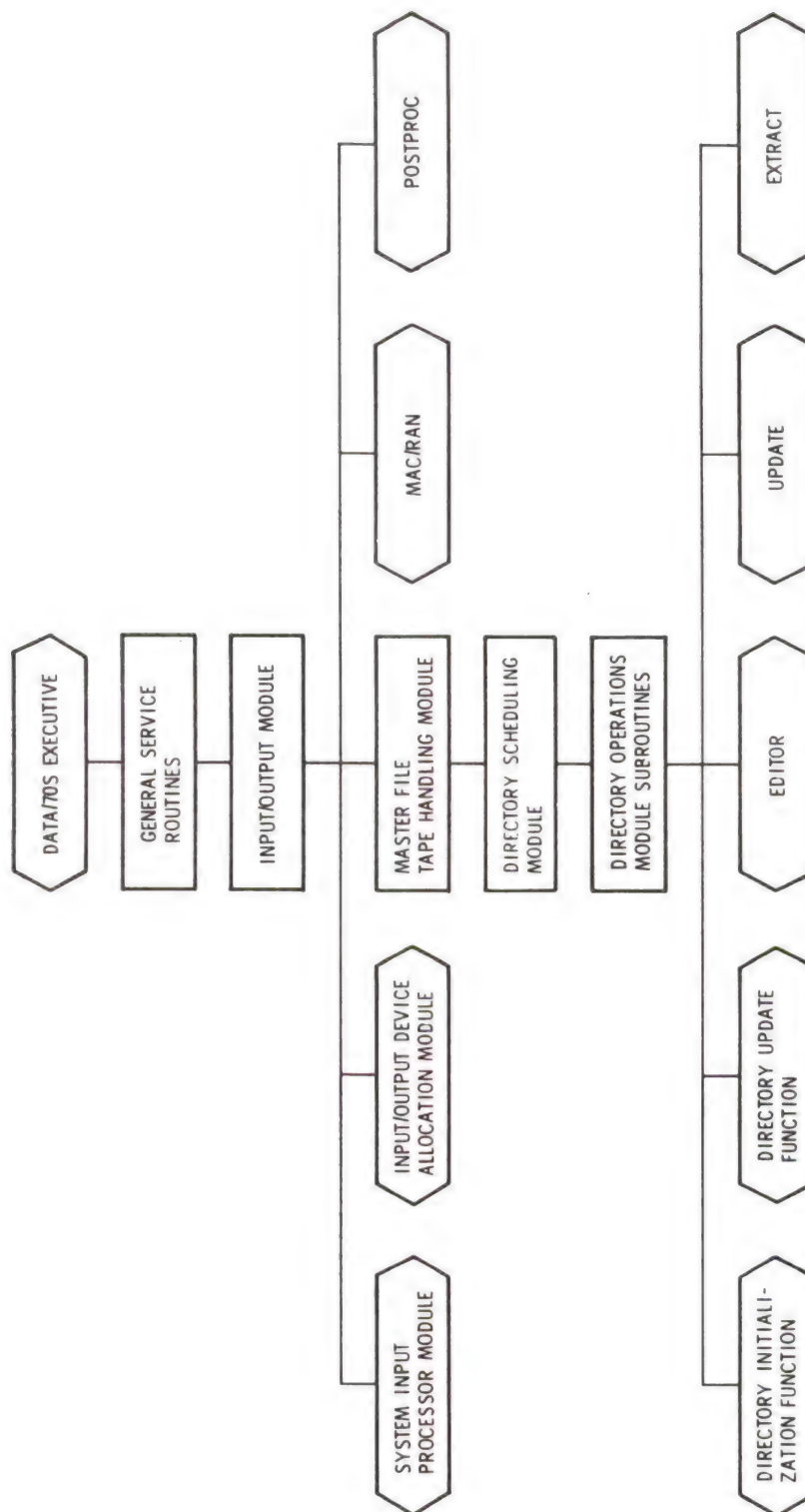
FIGURE B-8. DATA/70S OVERLAY STRUCTURE

to be made to the nominal system-control parameters (including a classified/ unclassified flag).

In execution, the program is designed to be fully automated. Console messages are issued instructing the operator when tape mounts are required. The operator is instructed to mount specific Directory tapes and Master File tapes and is told which tape drives require scratches to be mounted. Messages are also provided telling the operator what files have been placed on specific scratch tapes so that in the event of an abnormal program termination, inter- mediate tapes may be labeled and saved for restart. The operator is always informed of the specific drive or permissible set of drives for all requested tape mounts.

Any abnormal conditions that occur during a run, such as invalid tape labels or unrecoverable parities, cause operator instructions to be dis- played along with the possible recovery options that may be selected. Operator instructions to the program are handled through the setting of sense switches.

Some other features of the automated system include:

- Dynamic module allocation of available working storage to optimize core usage

- Automatic tape header-label generation and checking to assure correct tape mounts

- Use of Extended Core Storage on the 6600 and direct access drum features on the 1108

- Restart capability provided at any phase of operation

- User-selected I/0 record lengths to allow optimization of file handling for particular computer systems

- Generalized machine-independent, open-ended, core and file sorting routines

- Extensive I/0-error recovery procedures

- A run-simulation capability that may be used to estimate the run time of large Master File UPDATE or EXTRACT runs

- A simulation capability for predicting tape assignments for a specific number of available tape drives

- Computer-independent character manipulation based on the number of characters per computer word

- Program-controlled end-of-reel processing based on tape footage calculations

- Multiple output tape drives for a particular external file to save rewind time (when enough tape drives are available)

- Printed-output page numbering, variable page titling, and line counting

The DATA/70S program is designed to provide a fully automated capability with a simple user/machine interface that frees the data analyst from most of the procedural tasks associated with analyzing large volumes of data and provides him with a fast, efficient means of generating complete and concise results.

APPENDIX C

DATA/70S PROCESSING OPTIONS

DATA/70S implements the various processing options available in MAC/RAN via a special language that minimizes and simplifies the execution instructions that are input to the system. (The concept is described in Volume 1, Section 4.) There are four types of executable inputs: (1) Process Control Cards, (2) Management Control Cards, (3) Postprocessing Disposition Cards, and (4) File Identification Cards. It is the purpose of this appendix to completely describe all of the various processing options available in DATA/70S via the Process Control Cards and to briefly describe the modifications that occur to the Identification Indicator as the result of execution.

The Identification Indicator assigned to each new channel of data entered into the Master File is composed of an encoded 20-character alphanumeric array. As data are processed in MAC/RAN in one or more of the processing options, entries or modifications are made to characters 19 and 20 of the original 20-character Identification Indicator, and up to 10 new characters are appended to form a new Identification Indicator of up to 30 characters. Thus, any Identification Indicator that contains an entry in characters 19, or more than 20 characters altogether, must identify processed data. These new characters are added to the original Identification Indicator to provide (1) a permanent record of the processing history associated with each channel of processed data and (2) a unique Identification Indicator entry in the directories for each channel of data that is processed and subsequently returned to the Master File for permanent storage.

The processing options that can be submitted to DATA/70S in the form of Process Control Cards are presented in Table C-1, which shows (1) the corresponding code words, (2) the execution parameters, (3) the modifications to the Identification Indicator, and (4) a brief description of the function to be performed.

Figure C-1(a) shows an example of the Identification Indicator for an unprocessed data file. After subjecting the file to (1) trend removal, (2) (2) Butterworth lowpass filtering, and (3) integration, the new Identification Indicator appears as shown in Figure C-1(b). The code words corresponding to the performed operations are DETN, TFILLP, and PINT, whose symbols are T, L, and I, respectively. The symbol D at character 20 indicates that the original velocity data (V) were integrated to obtain displacement.

(a) For the original data: | 4 | 2 | F | E | V | V | 1 | 0 | 0 | A | 1 | 8 | 0 | R | 0 | 8 | 5 | | | V |

(b) For the processed data: | 4 | 2 | F | E | V | V | 1 | 0 | 0 | A | 1 | 8 | 0 | R | 0 | 8 | 5 | | | D | T | L | I |

FIGURE C-1. ORIGINAL AND MODIFIED IDENTIFICATION INDICATOR

C-2

TABLE C-1.   DATA/70S PROCESSING REQUEST OPTIONS

Code Word	Parameters	Character 19	20	21 to 30	Function
		Symbol			
CALBST	Number of calibration steps Physical unit factors	None	None	None	Step calibrate
CALBSTC	Physical unit factors	None	None	None	Continuation of CALBST
CALBSS	Number of calibration steps Physical unit factor	None	None	None	Step and sinusoidal calibration
DECI	Decimation index	None	None	D	Decimation
EDIT	Number of standard deviations Number of points in averaging span Maximum consecutive data replaced Maximum number data replaced	None	None	E	Wild-point editing
DETN	Degree polynomial removed Start time Number of points to fit	None	None	T	Trend removal
DECILP	Decimation index Cutoff frequency Number of points for preload Number of poles	None H	None None	L L	Lowpass tangent filter and decimate; Optionally: filter transfer function gain
FILTLP	Degree polynomial + 1 Decimation index Cutoff frequency Number of points for preload Number of poles	None H	None None	L L	Least squares detrend, Butterworth lowpass sine filter and decimate; Optionally: filter transfer function gain
FILTHP	Degree polynomial + 1 Decimation index Cutoff frequency Number of poles	None H	None None	H H	Least squares detrend, Butterworth highpass sine filter and decimate; Optionally: filter transfer gain
FILTBP	Degree of polynomial + 1 Decimation index Center frequency Bandwidth Number of poles	None H	None None	B B	Least squares detrend, Butterworth bandpass sine filter and decimate; Optionally: filter transfer gain
FILTBR	Degree of polynomial + 1 Decimation index Center frequency Bandwidth Number of poles	None H	None None	J J	Least squares detrend, Butterworth bandreject sine filter and decimate; Optionally: filter transfer gain

TABLE C-1. (CONTINUED)

Code Word	Parameters	Character 19	Character 20	Character 21 to 30	Function
		Symbol			
TFILLP	Degree of polynomial + 1 Decimation index Cutoff frequency Number of points for preload Number of poles	None H	None None	L L	Least squares detrend, Butterworth lowpass tangent filter and decimate; Optionally: filter transfer gain
TFILHP	Degree of polynomial + 1 Decimation index Cutoff frequency Number of poles	None H	None None	H H	Least squares detrend, Butterworth highpass tangent filter and decimate; Optionally: filter transfer gain
TFILBP	Degree of polynomial + 1 Decimation index Center frequency Bandwidth Number of poles	None H	None None	B B	Least squares detrend, Butterworth bandpass tangent filter and decimate; Optionally: filter transfer gain
TFILBR	Degree of polynomial + 1 Decimation index Center frequency Bandwidth Number of poles	None H	None None	J J	Least squares detrend, Butterworth bandreject tangent filter and decimate; Optionally: filter transfer gain
CSFLLP	Degree of polynomial + 1 Decimation index Cutoff frequency Number points for preload Number of poles Ripple index	None H	None None	L L	Least squares detrend, Chebychev Type I lowpass sine filter and decimate; Optionally: filter transfer gain
CSFLHP	Degree of polynomial + 1 Decimation index Cutoff frequency Number of poles Ripple index	None H	None None	H H	Least squares detrend, Chebychev Type I highpass sine filter and decimate; Optionally: filter transfer gain
CSFLBP	Degree of polynomial + 1 Decimation index Center frequency Bandwidth Number of poles Ripple index	None H	None None	B B	Least squares detrend, Chebychev Type I bandpass sine filter and decimate; Optionally: filter transfer gain
CSFLBR	Degree of polynomial + 1 Decimation index Center frequency Bandwidth Number of poles Ripple index	None H	None None	J J	Least squares detrend, Chebychev Type I bandreject sine filter and decimate; Optionally: filter transfer gain

TABLE C-1. (CONTINUED)

Code Word	Parameter	Character			Function
		19	20	21 to 30	
		Symbol			
CTFLLP	Degree of polynomial + 1 Decimation index Cutoff frequency Number of points for preload Number of poles Ripple index	None H	None None	L L	Least squares detrend, Chebychev Type I lowpass tangent filter and decimate; Optionally: filter transfer gain
CTFLHP	Degree of polynomial + 1 Decimation index Cutoff frequency Number of poles Ripple index	None H	None None	H H	Least squares detrend, Chebychev Type I highpass tangent filter and decimate; Optionally: filter transfer gain
CTFLBP	Degree of polynomial + 1 Decimation index Center frequency Bandwidth Number of poles Ripple index	None H	None None	B B	Least squares detrend, Chebychev Type I bandpass tangent filter and decimate; Optionally: filter transfer gain
CTFLBR	Degree of polynomial + 1 Decimation index Center frequency Bandwidth Number of poles Ripple index	None H	None None	J J	Least squares detrend, Chebychev Type I bandreject tangent filter and decimate; Optionally: filter transfer gain
FILTRC	Degree of polynomial + 1 Decimation index Cutoff frequency	None H	None None	L L	Least squares detrend, exponential filter and decimate; Optionally: filter transfer gain
FILTST	Degree of polynomial + 1 Decimation index Center frequency Bandwidth	None H	None None	B B	Least squares detrend, single trend filter and decimate; Optionally: filter transfer gain
ZOOM	Left frequency bound Right frequency bound Cutoff frequency Number of points for preload Number of poles	None H	None None	B B	Frequency band isolation; Optionally: filter transfer gain
SPDF	Number of intervals Number of data points Left margin Right margin	+, (	None	,	Histogram, probability density function and normality check

TABLE C-1. (CONTINUED)

Code Word	Parameters	Character 19	Character 20	Character 21 to 30	Function
		Symbol			
FOUR	Size of transform Tapering Starting zoom frequency Stopping zoom frequency Zoom sampling rate	B, C	None	A	Fourier transform, real and imaginary components
FOURIN	Sampling rate	Blank	None	K	Inverse Fourier transform
PSDT	Number of points/segment Tapering index Effective bandwidth Mean removal index Decimation index	G	None	X	Power spectral density
PSDTZM	Starting zoom frequency Stopping zoom frequency Sampling rate	None	None	None	Continuation (zoom only)
CSDTMP	Number of points/segment Tapering index Effective bandwidth Mean removal index Decimation index Input-output index	X, A G H S	None None None None	X X X X	Cross-spectral densities modulus and phase; Optionally: power spectral densities; transfer function gain; coherence
CSDTZM	Starting zoom frequency Stopping zoom frequency Sampling rate	None	None	None	Continuation (zoom only)
TRNTGP	Number of points/segment Tapering index Effective bandwidth Mean removal index Decimation factor Input-output index	H, A G S	None None None	X X X	Transfer function gain and phase; Optionally: power spectral densities; coherence
TRNTZM	Starting zoom frequency Stopping zoom frequency Sampling rate	None	None	None	Continuation (zoom only)
COHTOR	Number of points/segment Tapering index Effective bandwidth Mean removal index Decimation factor Input-output index	S	None	X	Ordinary coherence

TABLE C-1. (CONTINUED)

Code Word	Parameters	Character			Function
		19	20	21 to 30	
		Symbol			
COHTZM	Starting zoom frequency Stopping zoom frequency Sampling rate	None	None	None	Continuation (zoom only)
CSDTRI	Number of points/segment Tapering index Effective bandwidth Mean removal index Decimation factor Input-output index	D,E G H,A S	None None None None	X X X X	Cross-spectral density, real and imaginary; Optionally: power spectral densities; transfer function gain and phase; coherence
TRNTRI	Number of points/segment Tapering index Effective bandwidth Mean removal index Decimation factor Input-output index	U,V G S	None None None	X X X	Transfer function, real and imaginary; Optionally: power spectral densities; coherence
PSDF	Original sampling rate Type of window Effective bandwidth Decimation factor Starting zoom frequency Stopping zoom frequency	G	None	Q	Power spectral density
CSDFMP	Original sampling rate Type of window Effective bandwidth Decimation factor Starting zoom frequency Stopping zoom frequency	D,E G H,A S	None None None None	Q Q Q Q	Cross-spectral densities, modulus and phase; Optionally: power spectral densities; transfer function gain and phase; coherence
TRNFGP	Original sampling rate Type of window Effective bandwidth Decimation factor Starting zoom frequency Stopping zoom frequency	H,A G S	None None None	Q Q Q	Transfer function, gain and phase Optionally: power spectral densities; coherence
COHFOR	Original sampling rate Type of window Effective bandwidth Decimation factor Starting zoom frequency Stopping zoom frequency	S G	None None	Q Q	Ordinary coherence; Optionally: power spectral density

TABLE C-1. (CONTINUED)

Code Word	Parameters	Character			Function
		19	20	21 to 30	
		Symbol			
CSDFRI	Original sampling rate	G, D, E	None	Q	Power spectral density and cross-spectral density, real and imaginary;
	Type of window				
	Effective bandwidth	H	None	Q	Optionally: transfer function gain and phase;
	Decimation factor				
	Starting zoom frequency	S	None	Q	coherence;
	Stopping zoom frequency	U	None	Q	transfer function, real and imaginary
TRNFRI	Original sampling rate	U, V	None	Q	Transfer function, real and imaginary;
	Type of window	G	None	Q	Optionally: power spectral density;
	Effective bandwidth	H, A	None	Q	transfer function gain and phase;
	Decimation factor	S	None	Q	coherence
	Starting zoom frequency				
	Stopping zoom frequency				
PADD	None	None	None	*	Addition of pairs of files
PSUB	None	None	None	−	Subtraction of pairs of files
PMUL	None	None	None	*	Multiplication of pairs of files
PDIV	None	None	None	/	Division of pairs of files
PCAD	Value of constant	None	None	0	Addition of a constant
PCMU	Value of constant	None	None	1	Multiplication of a constant
PWIR	Number of duplicates	None	None	None	Duplication of a file
PSIG	None	None	None	4	Signed step function
PABS	None	None	None	5	Absolute value
PLOG	None	None	None	6	Natural log
PEXP	None	None	None	7	Exponential
PPOW	Value of power	None	None	8	Raise to a power
PSQT	None	None	None	9	Square root
PSIN	None	None	None	=	Sine
PCOS	None	None	None	(	Cosine
PATN	None	None	None	)	Arctangent
PDEL	First data value of delayed file	None	None	S	Delay by one ΔT

TABLE C-1. (CONTINUED)

Code Word	Parameters	Character			Function
		19	20	21 to 30	
		Symbol			
PFILRC	Value of filter constant	None	None	L	Exponential filter
PINT	None	None	P → I A → V V → D	I	Integration
PDIF	None	None	I → P V → A D → V	Z	Differentiation
PFILLP	Cutoff frequency Number of poles	None	None	L	Butterworth lowpass sine filter
PFILHP	Cutoff frequency Number of poles	None	None	H	Butterworth highpass sine filter
PFILBP	Center frequency Bandwidth Number of poles	None	None	B	Butterworth bandpass sine filter
PFILBR	Center of frequency Bandwidth Number of poles	None	None	J	Butterworth bandreject sine filter
PTIMAD	Value of constant	None	None	P	Addition of a constant to time
PTIMMU	Value of constant	None	None	Φ	Multiplication of time by a constant
PRAN	None	None	None	None	Replace data with uniform random values
PMAC	Value of constant	None	None	2	Multiply first file of a pair by a constant and add to a second file
PMAD	None	None	None	3	Multiply first two files of a group of three and add to the third file
PSTC	Value of constant Start time Stop time	None	None	S	Replace data with a constant
PGAU	None	None	None	None	Replace data with Gaussian random values
CADD	None	None	None	+	Complex addition of pairs of files
CSUB	None	None	None	−	Complex subtraction of pairs of files

TABLE C-1. (CONTINUED)

Code Word	Parameters	Character 19	20	21 to 30	Function
		Symbol			
CMUL	None	None	None	*	Complex multiplication of pairs of files
CDIV	None	None	None	/	Complex division of pairs of files
CCAD	Value of real constant Value of imaginary constant	None	None	0	Addition of a complex constant
CCMU	Value of real constant Value of imaginary constant	None	None	1	Multiplication by a complex constant
CONJ	None	None	None	G	Complex conjugate
CPOL	None	U,V→H,A B,C→F,P D,E→X,A	None	F	Conversion to polar coordinates
CREC	None	H,A→U,V F,P→B,C X,A→D,E	None	Y	Conversion to rectangular coordinates
CLOG	None	None	None	6	Complex natural log
CEXP	None	None	None	7	Complex exponential
CSTC	Value of real constant Value of imaginary constant Start time Stop time	None	None	S	Replace complex data with a complex constant
PIND	Value of increment Start value	None	None	None	Replace data value with linear functions
CONF	Type of computation Number of data points Starting value of output independent variable Convolution/correlation index	None	None	V	Convolution
FUNCIN	y_1, y_2, y_3, y_4, y_5, y_6, y_7	None	None	None	Replace data with input function
FUNCINC	y_8, y_9, y_{10}, y_{11}, y_{12}, y_{13}, y_{14}	None	None	None	Continuation of previous card
FUNCMR	Output device index	None	None	None	Prepare data for MAC/RAN stand-alone

TABLE C-1. (CONTINUED)

Code Word	Parameters	Character 19 Symbol	20 Symbol	21 to 30 Symbol	Function
OUTPPL	Plot height Plot width Axis type indicator {X max or {X log cycle X origin {Y max or {Y log cycle Y origin	None	None	None	Intermediate plotting
OUTPPR	None	None	None	None	Intermediate printing
OUTPPP	Plot height Plot width Axis type indicator {X max or {X log cycle size X origin {Y max or {Y log cycle Y origin	None	None	None	Intermediate printer plots
CORRAU	Normalizing index Maximum time delay	R	None	R	Autocorrelation
CORRCR	Normalizing index Maximum time delay	Q Q, R	None None	R None	Cross-correlation Optionally: autocorrelation
BTPS	Maximum time delay Computation bandwidth Start frequency Number of frequency components Smoothing index	G	None	R	Power spectral density
BTCS	Maximum time delay Computation bandwidth Start frequency Number of frequency components Smoothing index Normalizing index	X, T, G	None	R	Power spectral density and cross-spectral density modulus and phase; Optionally: auto and cross correlations
LINS	Coherency confidence interval Frequency response confidence interval Output function index	S, Z, Y H, A	None	U	Ordinary coherence, multiple coherence, partial coherence, and transfer function gain and phase

TABLE C-1. (CONTINUED)

Code Word	Parameters	Character			Function
		19	20	21 to 30	
		Symbol			
ENAV	Number of functions Previous sum or mean Previous sum of squares or mean squares	H, N J, W L	None	W	Ensemble mean, mean square sum, sum of squares, and variance
ENAVTA	Advance coefficients	None	None	None	Input time advance
ENAVTAC	Advance coefficients	None	None	None	Continuation
ENAVSA	Scale alignment terms	None	None	None	Input scale alignment coefficients
ENAVSAC	Scale alignment terms	None	None	None	Continuation
ENAVWT	Weighting factors	None	None	None	Input weight coefficients
ENAVWTC	Weighting factors	None	None	None	Continuation
SHOXDE	Number of damping ratios Lowest damping ratio Damping ratio increment Number of natural frequencies Lowest natural frequency Frequency increment Excitation delay time	K	D	•	Shock spectrum analysis of relative deflection
SHOXDEC	Length of residual time Output amplitude index Input type index Front end taper factor Rear end taper factor	None	None	None	Continuation
SHOXVE	Number of damping ratios Lowest damping ratio Damping ratio increment Number of natural frequencies Lowest natural frequency Frequency increment Excitation delay time	K	V	•	Shock spectrum analysis of pseudo-velocity
SHOXVEC	Length of residual time Output amplitude index Maximum pressure Input type index Front end taper factor Rear end taper factor	None	None	None	Continuation

TABLE C-1.   (CONTINUED)

Code Word	Parameter	Character 19 (Symbol)	Character 20 (Symbol)	Character 21 to 30 (Symbol)	Function
SHOXAC	Number of damping ratios Lowest damping ratio Damping ratio increment Number of natural frequencies Lowest natural frequency Frequency increment Excitation delay time	K	A	•	Shock spectrum analysis of equivalent static acceleration
SHOXACC	Length of residual time Output amplitude index Maximum pressure Input type index Front end taper factor Rear end taper factor	None	None	None	Continuation
SHTHDE	Damping ratio Natural frequency Type of input index Front end taper Rear end taper	Φ	D	•	Relative deflection
SHTHVE	Damping ratio Natural frequency Type of input index Front-end taper Rear end taper	Φ	V	•	Pseudovelocity
SHTHAC	Damping ratio Natural frequency Type of input index Front-end taper Rear-end taper	Φ	A	•	Equivalent static acceleration
RMST	RMS time history Integration time	I	None	M	Root mean square
TOCTPD	Highest mean frequency Number of octaves	G	None	M	One-third octave power spectral density
TOCTRD	Highest mean frequency Number of octaves	O	None	M	One-third octave root-mean-square spectral density
TOCTPS	Highest mean frequency Number of octaves	1	None	M	One-third octave power spectrum
TOCTRS	Highest mean frequency Number of octaves	2	None	M	One-third octave root-mean-square spectrum

TABLE C-1. (CONCLUDED)

Code Word	Parameters	Character			Function
		19	20	21 to 30	
		Symbol			
TOCTFL	Highest mean frequency	3	None	M	One-third octave filter
TOCTFM	Highest mean frequency	4	None	M	One-third filtered mean square
TOCTFR	Highest mean frequency	5	None	M	One-third filtered root mean square
PLTF	Lower clamping frequency Upper clamping frequency Starting frequency Sensitivity multiplier Decimation index Cutoff frequency Number of poles	6, 7, F	None	N	Simple phase-lock-loop tracking filter generating frequency lock and amplitude
PLTFAB	Lower clamping frequency Upper clamping frequency Starting frequency Sensitivity multiplier Decimation index Cutoff frequency Number of poles	6, 7 F, S, P H, A	None	N	Phase-lock-loop tracking filter with tracking function generating frequency, lock amplitude, coherence, phase, amplitude ratio, relative phase, and harmonic amplitudes
PLTFAL	Lower clamping frequency Upper clamping frequency Starting frequency Sensitivity multiplier Decimation index Cutoff frequency Number of poles	6, 7 F, S, P	None	N	Phase-lock-loop tracking filter with tracking function generating frequency, lock amplitude, coherence phase and amplitude phase, amplitude ratio and relative phase for fundamental and harmonics
PLTFHR	1-7 harmonics	None	None	None	Input harmonic values for PLTFAR and PTLFAL
PLTFHRC	8-14 harmonics	None	None	None	Continuation
CRSH	Y axis increment Minimum Y value Maximum Y value Maximum X value H. I. C. index	+	None	,	Histogram

DISTRIBUTION LIST

DEPARTMENT OF DEFENSE

Assistant to the Secretary of Defense
Atomic Energy
    ATTN: Honorable Donald R. Cotter

Director
Defense Advanced Research Projects Agency
    ATTN: NMRO
    ATTN: PMO
    ATTN: STO

Director
Defense Civil Preparedness Agency
    ATTN: Technical Library
    ATTN: Staff Director of Research,
        George N. Sisson

Director
Defense Communications Agency
    ATTN: Code 930, Franklin D. Moore

Defense Documentation Center
12 cy ATTN: TC

Director
Defense Intelligence Agency
    ATTN: Technical Library

Director
Defense Nuclear Agency
2 cy ATTN: STTL, Technical Library
    ATTN: STSI, Archives
    ATTN: DDST
2 cy ATTN: SPSS

Director of Defense Research & Engineering
Department of Defense
    ATTN: AD/SW
    ATTN: DD/S&SS
    ATTN: DD/TWP
    ATTN: DD/I&SS
    ATTN: AD/NP

Commander
Field Command
Defense Nuclear Agency
    ATTN: FCT
    ATTN: FCPR

Commandant
Industrial College of the Armed Forces
    ATTN: Technical Library

Director
Interservice Nuclear Weapons School
    ATTN: Technical Library

Director
Joint Strategic TGT Planning Staff JCS
    ATTN: STINFO Library

DEPARTMENT OF DEFENSE (Continued)

Chief
Livermore Division Field Command DNA
Lawrence Livermore Laboratory
    ATTN: FCTA-D

Commandant
National War College
    ATTN: NWCLB-CR

Chief
Test Construction Division
Field Command Test Directorate
Defense Nuclear Agency
    ATTN: FCTD-N

Weapons Systems Evaluation Group
    ATTN: Document Control

DEPARTMENT OF THE ARMY

Assistant Chief of Staff for Force Development
    ATTN: Technical Library

Commander
Ballistic Defense System Command
    ATTN: BDMSC-TEN, Noah J. Hurst

Director
BMD Advanced Technical Center
Huntsville Office
    ATTN: CRDABH-S
    ATTN: CRDABH-X

Manager
BMD Program Office
    ATTN: John Shea

Chief of Research, Development, & Acquisition
    ATTN: DAMA-CSM-N, LTC E. V. Deboeser, Jr.
    ATTN: Technical Library

Director
Construction Engineering Research Laboratory
    ATTN: CERL-SL

Commander
Frankford Arsenal
    ATTN: L. Baldini

Commander
Harry Diamond Laboratories
    ATTN: AMXDO-TI, Technical Library
    ATTN: Frank J. Vrateric
    ATTN: AMXDO-RBI, John A. Rosado
    ATTN: AMXDO-RBH, James H. Gwaltney
    ATTN: Allen Holmes
    ATTN: AMXDO-NP

Commander
Picatinny Arsenal
    ATTN: Technical Library

Director
U.S. Army Ballistic Research Laboratories
    ATTN: AMXBR-TB, J. T. Frasier
    ATTN: AMXBR-X, Julius J. Meszaros
    ATTN: J. H. Keefer
    ATTN: Technical Library, Edward Baicy
    ATTN: B. Reiter

Commander and Director
U.S. Army Cold Regions Research & Engineering Laboratory
    ATTN: G. Swinzow

Commander
U.S. Army Communications Command
    ATTN: Technical Library

Commander
U.S. Army Electronics Command
    ATTN: AMSEL-TL-IR, Edwin T. Hunter

Commander
U.S. Army Engineer Center
    ATTN: ATSEN-SY-L

Project Engineer
U.S. Army Engineer District, Huntsville
    ATTN: HNDSE-R, Michael M. Dembo

Division Engineer
U.S. Army Engineer District, Ohio River
    ATTN: Technical Library

Commandant
U.S. Army Engineer School
    ATTN: S. Grazier

Division Engineer
U.S. Army Engineer District, Missouri River
    ATTN: Technical Library

Director
U.S. Army Engineer Waterways Experiment Station
    ATTN: Kim Davis
    ATTN: P. Hadala
    ATTN: D. K. Butler
    ATTN: Guy Jackson
    ATTN: John N. Strange
    ATTN: Behzad Rohani
    ATTN: Leo Ingram
    ATTN: Technical Library
    ATTN: William Flathau
    ATTN: A. Rooke
    ATTN: James Ballard

Commander
U.S. Army Materials & Mechanics Research Center
    ATTN: Technical Library

Director
U.S. Army Material Systems Analysis Agency
U.S. Army Aberdeen R&D Center
    ATTN: Joseph Sperazza
    ATTN: M. Reches

Commander
U.S. Army Materiel Command
    ATTN: Technical Library

Commander
U.S. Army Materiel Command
Foreign Science & Technology Center
    ATTN: Research & Concepts Branch

Commander
U.S. Army Missile Command
    ATTN: AMSMI-XS, Chief Scientist
    ATTN: Technical Library

Commander
U.S. Army Mobility Equipment R&D Center
    ATTN: STSFB-MW
    ATTN: Technical Library
    ATTN: STSFB-XS

Commander
U.S. Army Nuclear Agency
    ATTN: CDINS-E
    ATTN: Technical Library

Commandant
U.S. Army War College
    ATTN: Library

Commander
U.S. Army Weapons Command
    ATTN: Technical Library

U.S. Army Research Office
    ATTN: Information Processing Office
    ATTN: Acquisition Department

DEPARTMENT OF THE NAVY

Chief of Naval Research
Navy Department
    ATTN: Code 464, Thomas P. Quinn
    ATTN: Nicholas Perrone
    ATTN: Technical Library
    ATTN: Code 464, Jacob L. Warner

Officer-in-Charge
Civil Engineering Laboratory
Naval Construction Battalion Center
    ATTN: Technical Library
    ATTN: Stan Takahashi
    ATTN: R. J. Odello

Chief of Information
Navy Department
    ATTN: Acquisition Department

DEPARTMENT OF THE NAVY (Continued)

Commander
Naval Facilities Engineering Command
Heatquarters
    ATTN: Code 03A
    ATTN: Code 04B
    ATTN: Technical Library

Superintendent
Naval Postgraduate School
    ATTN: Code 2124, Technical Reports Librarian

Director
Naval Research Laboratory
    ATTN: Code 8403, Robert O. Belshem
    ATTN: Code 2027, Technical Library

Commander
Naval Sea Systems Command
    ATTN: Code 03511
    ATTN: Code 03511, Carl H. Pohler
    ATTN: ORD-91313, Library

Commander
Naval Ship Engineering Center
    ATTN: Technical Library

Commander
Naval Ship Research and Development Center
    ATTN: Code L42-3, Library

Commander
Naval Ship Research and Development Center
Underwater Explosive Research Division
    ATTN: Code 17, William W. Murray
    ATTN: John Gordon
    ATTN: Technical Library
    ATTN: Edward W. Palmer

Commander
Naval Surface Weapons Center
    ATTN: Code 730, Technical Library
    ATTN: Code 1224, Navy Nuclear Programs Office

Commander
Naval Surface Weapons Center
Dahlgren Laboratory
    ATTN: Technical Library

Commander
Naval Undersea Center
    ATTN: E. P. Cooper
    ATTN: Technical Library

President
Naval War College
    ATTN: Technical Library

Commander
Naval Weapons Center
    ATTN: Code 533, Technical Library

DEPARTMENT OF THE NAVY (Continued)

Commanding Officer
Naval Weapons Evaluation Facility
    ATTN: R. Hughes
    ATTN: Technical Library

Director
Strategic Systems Project Office
Navy Department
    ATTN: NSP-273
    ATTN: NSP-272
    ATTN: NSP-43, Technical Library

DEPARTMENT OF THE AIR FORCE

AF Armament Laboratory, AFSC
    ATTN: DLOSL-LIB

AF Cambridge Research Laboratories, AFSC
    ATTN: LWW Ker C. Thompson
    ATTN: SUDL AFCRL Research Library

AF Institute of Technology, AU
    ATTN: Library AFIT, Bldg 640, Area B

AF Office of Scientific Research
    ATTN: AFOSR Library
    ATTN: Acquisition Department

AF Weapons Laboratory, AFSC
    ATTN: DEX
    ATTN: DEV, M. A. Plamondon
    ATTN: DE-I
    ATTN: DEV, Jimmie L. Bratton
    ATTN: SUL
    ATTN: DYT
    ATTN: Robert Henny
    ATTN: Robert Port

Headquarters
Air Force Systems Command
    ATTN: Technical Library

Commander
Armament Development & Test Center
    ATTN: ADBRL-2
    ATTN: Technical Library

Commander
Foreign Technology Division, AFSC
    ATTN: TD-BTA Library
    ATTN: TDFBD
    ATTN: TDPMG
    ATTN: ETET, CAPT Richard C. Husemann

HQ USAF/RD
    ATTN: RDPM
    ATTN: RDQPN

DEPARTMENT OF THE AIR FORCE (Continued)

Oklahoma State University
Field Office for Weapons Effectiveness
    ATTN: Edward Jackett

SAMSO/DE
    ATTN: DEB

SAMSO/DY
    ATTN: DYS

SAMSO/MN
    ATTN: MNI
    ATTN: MNNH
    ATTN: MMH
    ATTN: MNN

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

Division of Military Application
U.S. Energy Research and Development Administration
    ATTN: Document Control for Test Office

Holmes & Narver, Inc.
    ATTN: R. Kennedy

University of California
Lawrence Livermore Laboratory
    ATTN: Technical Information Department L-3
    ATTN: Larry W. Woodruff, L-125
    ATTN: Barbara Germain

Los Alamos Scientific Laboratory
    ATTN: Document Control for Al Davis
    ATTN: Document Control for Tom Dowler
    ATTN: Document Control for G. R. Spillman
    ATTN: Document Control for C. Cremer
    ATTN: Document Control for G. Dials
    ATTN: Document Control for Reports Library

Sandia Laboratories
Livermore Laboratory
    ATTN: Document Control for Technical Library
    ATTN: Document Control for T. Gold
    ATTN: Document Control for L. Hill

Sandia Laboratories
    ATTN: Document Control for Walter Herrmann
    ATTN: Document Control for John Colp
    ATTN: Document Control for W. Roherty
    ATTN: Document Control for William Caudle
    ATTN: Document Control for A. J. Chaban
    ATTN: Document Control for W. Altsmeirer
    ATTN: Document Control for William Patterson
    ATTN: Document Control for M. L. Merritt
    ATTN: Document Control for John Keizur
    ATTN: Document Control for Luke J. Vortman
    ATTN: Document Control for 3141 Sandia Report Collection

Union Carbide Corporation
Holifield National Laboratory
    ATTN: Civil Defense Research Project
    ATTN: Document Control for Technical Library

OTHER GOVERNMENT

Department of the Interior
Bureau of Mines
Twin Cities Research Center
    ATTN: R. E. Thill
    ATTN: Technical Library

Department of the Interior
Bureau of Mines
    ATTN: Technical Library

Department of the Interior
Bureau of Mines
    ATTN: James J. Scott

Department of the Interior
U.S. Geological Survey
    ATTN: Cecil B. Raleigh
    ATTN: J. H. Healy

National Science Foundation
Office of Programs & Resources
Research Applied to National Needs
    ATTN: Thomas Aiken
    ATTN: Frances M. Pentecast
    ATTN: Acquisition Department
    ATTN: RANN Document Control

DEPARTMENT OF DEFENSE CONTRACTORS

Aerospace Corporation
    ATTN: Technical Information Services
    ATTN: Prem N. Mathur
    ATTN: R. Strickler
    ATTN: George Young

Agbabian Associates
    ATTN: M. Agbabian

Analytic Services, Inc.
    ATTN: George Hesselbacher

Applied Theory, Inc.
2 cy ATTN: John G. Trulio

Artec Associates, Inc.
    ATTN: Steven Gill

AVCO Research & Systems Group
Government Products Group
    ATTN: Research Library, A830, Rm 7201
    ATTN: David Henderson
    ATTN: Frank Lasher
    ATTN: John Atanasoff

Battelle Memorial Institute
    ATTN: Technical Library
    ATTN: R. W. Klingesmith

The Boeing Company
    ATTN: Reynold Atlas
    ATTN: R. H. Carlson
    ATTN: Aerospace Library

Brown Engineering Company, Inc.
    ATTN: J. Cahoon
    ATTN: Manu Patel

California Institute of Technology
    ATTN: Thomas J. Ahrens

California Research & Technology, Inc.
    ATTN: Ken Kreyenhagen
    ATTN: Technical Library

University of California, Berkeley
    ATTN: G. Sackman

Calspan Corporation
    ATTN: Technical Library

Cambridge Acoustical Associates, Inc.
    ATTN: M. C. Junger

Civil/Nuclear Systems Corporation
    ATTN: Robert Crawford

Columbia University
Department of Civil Engineering
    ATTN: F. DiMaggio
    ATTN: H. Bleich

University of Dayton
    ATTN: Hallock F. Swift

EG & G, Inc.
Albuquerque Division
    ATTN: Technical Library

Engineering Societies Library
    ATTN: Ann Mott

Environmental Research Corporation
    ATTN: W. W. Hays

General American Transportation Corporation
General American Research Division
    ATTN: G. L. Neidhardt

General Dynamics Corporation
Pomona Operation
    ATTN: Keith Anderson

General Dynamics Corporation
Electric Boat Division
    ATTN: L. H. Chan

General Electric Company
Space Division
    ATTN: M. H. Bortner, Space Sciences
           Laboratory

General Electric Company
TEMPO-Center for Advanced Studies
    ATTN: DASIAC

General Research Corporation
    ATTN: Benjamin Alexander

Georgia Institute of Technology
Georgia Technology Research Institute
    ATTN: S. V. Hanagud
    ATTN: L. W. Rehfield

IIT Research Institute
    ATTN: R. E. Welch
    ATTN: Technical Library
    ATTN: Milton R. Johnson

Institute for Defense Analyses
    ATTN: IDA Librarian, Ruth S. Smith

J. H. Wiggins Company, Inc.
    ATTN: Jon Collins

J. L. Merritt Consulting & Special Engineering Services, Inc.
    ATTN: Technical Library
    ATTN: J. L. Merritt

Kaman Avidyne
Division of Kaman Sciences Corporation
    ATTN: G. Zartarian
    ATTN: Technical Library
    ATTN: E. S. Criscione
    ATTN: Norman P. Hobbs

Kaman Sciences Corporation
    ATTN: Gunning Butler, Jr.
    ATTN: Paul A. Ellis
    ATTN: Frank H. Shelton
    ATTN: Library

Lockheed Missiles & Space Company, Inc.
    ATTN: Technical Library
    ATTN: M. Culp

Lockheed Missiles and Space Company
    ATTN: Tom Geers, D/52-33, Bldg 205
    ATTN: Technical Information Center, D/COLL

Lovelace Foundation for Medical Education
    ATTN: Technical Library
    ATTN: Assistant Director of Research, Robert K. Jones

Lowell Technological Institute Research Foundation
    ATTN: L. W. Thigpen

Martin Marietta Aerospace
Orlando Division
    ATTN: Al Cowan
    ATTN: M. Anthony
    ATTN: N. E. Singletary
    ATTN: G. Fotieo

McDonnell Douglas Corporation
    ATTN: Robert W. Halprin

Meteorology Research, Inc.
    ATTN: William D. Green

The Mitre Corporation
    ATTN: Library

Nathan M. Newmark Consulting Engineering Services
    ATTN: Nathan M. Newmark

University of New Mexico
Department of Campus Security and Police
    ATTN: G. E. Triandafalidis
    ATTN: H. D. Southward

Pacifica Technology
    ATTN: J. Kent
    ATTN: R. Bjork

Physics International Company
    ATTN: Document Control for Technical Library
    ATTN; Document Control for E. T. Moore
    ATTN: Document Control for Fred M. Sauer
    ATTN: Document Control for Larry A. Behrmann
    ATTN: Document Control for Dennis Orphal
    ATTN: Document Control for Robert Swift
    ATTN: Document Control for Charles Godfrey

Polytechnic Institute of Brooklyn
Department of Aerospace & Applied Mechanics
    ATTN: J. M. Klosner

R & D Associates
    ATTN: Bruce Hartenbaum
    ATTN: Sheldon Schuster
    ATTN: Henry Cooper
    ATTN: Cyrus P. Knowles
    ATTN: Harold L. Brode
    ATTN: Technical Library
    ATTN: J. G. Lewis
    ATTN: Jerry Carpenter

The Rand Corporation
    ATTN: C. C. Mow

Research Analysis Corporation
    ATTN: Documents Library

Science Applications, Inc.
    ATTN: D. E. Maxwell
    ATTN: David Bernstein

Science Applications, Inc.
    ATTN: John Mansfield
    ATTN: William M. Layson
    ATTN: R. Seebaugh

Science Applications, Inc.
    ATTN: C. Hudson
    ATTN: Technical Library
    ATTN: Michael McKay

Science Applications, Inc.
    ATTN: R. A. Shunk

Shock Hydrodynamics, Inc.
A Division of Whittaker Corporation
    ATTN: L. Zernow

Southwest Research Institute
    ATTN: Wilfred E. Baker
    ATTN: A. B. Wenzel

Stanford Research Institute
    ATTN: SRI Library, Rm G021
    ATTN: Lynn Seamans
    ATTN: Burt R. Gasten
    ATTN: George R. Abrahamson

Systems, Science and Software, Inc.
    ATTN: Robert T. Allen
    ATTN: Donald R. Grine
    ATTN: Edward Gaffrey
    ATTN: Thomas D. Riney
    ATTN: Technical Library
    ATTN: Ted Cherry
    ATTN: Carl Peterson

Terra Tek, Inc.
    ATTN: Sidney Green
    ATTN: A. H. Jones
    ATTN: Technical Library

Tetra Tech, Inc.
    ATTN: Technical Library
    ATTN: Li-san Hwang

Texas A & M University System
C/O Texas A & M Research Foundation
    ATTN: Harry Coyle
    ATTN: L. J. Thompson

The BDM Corporation
    ATTN: A. Lavagnino
    ATTN: Technical Library

The BDM Corporation
    ATTN: Richard Hensley

TRW Systems Group
    ATTN: Pravin Bhutta
    ATTN: William Rowan
    ATTN: Technical Information Center, S-1930
    ATTN: Paul Lieberman
    ATTN: Jack Farrell
    ATTN: Benjamin Sussholtz
    ATTN: Norm Lipner

TRW Systems Group
San Bernardino Operations
    ATTN: Fred Pieper
    ATTN: Greg Hulcher

Universal Analytics, Inc.
    ATTN: E. I. Field

DEPARTMENT OF DEFENSE CONTRACTORS (Continued)

University of Denver
Colorado Seminary
Denver Research Institute
    ATTN: Section Officer for Ron W. Buchanon
    ATTN: Section Officer for Fred P. Venditti
    ATTN: Section Officer for J. Wisotski
    ATTN: Section Officer for Technical Library

University of Maryland
Department of Civil Engineering
    ATTN: Bruce S. Berger

University of Oklahoma
Research Institute
    ATTN: John Thompson

URS Research Company
    ATTN: Technical Library
    ATTN: Ruth Schneider

The Eric H. Wang Civil Engineering Research Facility
    ATTN: Neal Baum
    ATTN: Larry Bickle

Washington State University
Administration Office
    ATTN: George Duval

Weidlinger Associates, Consulting Engineers
    ATTN: J. W. Wright
    ATTN: Melvin L. Baron

Weidlinger Associates, Consulting Engineers
    ATTN: J. Isenberg

Westinghouse Electric Company
Marine Division
    ATTN: W. A. Volz